SCIENCE ABSTRACTS.

Section A.—PHYSICS

NOVEMBER 1912.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1912.

GENERAL PHYSICS.

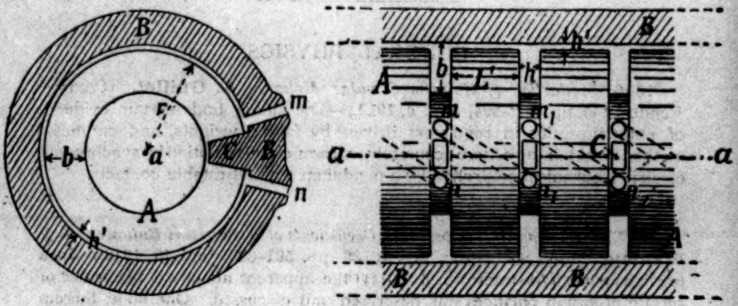
1606. *Production of Uniform Circular Motion.* **A. Guillet.** (Comptes Rendus, 155. pp. 392–394, Aug. 5, 1912.)—The author finds certain evidence of non-uniformity in regulators driven by falling weights, and outlines a method of obtaining a more accurately uniform circular motion by synchronous electric mechanism controlled by a pendulum with adjustable contacts.

C. P. B.

1607. *Variations in Temperature Coefficients of a Precision Balance.* **J. J. Manley.** (Roy. Soc., Proc. Ser. A. 86. pp. 591–600, July 20, 1912.)—In a previous paper [Abstract No. 3 (1911)] the apparent abnormal behaviour of certain precision balances was described and discussed. One point therein considered dealt with the displacement of the resting-point, R.P., of a beam, consequent upon a uniform rise or fall in the temperature of the instrument. The amount of such displacement for a change of 1 deg. C. was termed the temperature coefficient of a balance. In the present paper attention is directed to changes which may occur in the temperature coefficients of delicate balances. Peculiarities noted with a new balance disappeared after continued careful use of the balance. The conclusion is drawn that before a new, or comparatively new, precision balance can be safely used for securing trustworthy values of the highest order of accuracy, the instrument must be suitably "aged." A method of effecting this is suggested. A. W.

1608. *A New Principle for Air Pumps; the Molecular Pump.* **W. Gaede.** (Deutsch. Phys. Gesell., Verh. 14. 15. pp. 775–787, Aug. 15, 1912. Phys. Zeitschr. 13. pp. 864–870, Sept. 15, 1912. Paper read before the 83. Naturforscherversamml., Karlsruhe. Electrician, 70. pp. 48–50, Oct. 18, 1912.)—The author's pump is an entire departure from the von Guericke principle, the connection between the vessel to be exhausted and the delivery pipe, being at all times open. The author had repeated Knudsen's experiments on the flow of air through capillary tubes, and found that Knudsen's view, that the molecules are thrown back by the walls independently of what may be the angle of incidence, holds only for pressures below 0·001 mm. of Hg.

Above this pressure a gas film forms on the surface, which has the effect of causing the molecules to rebound preferentially in a direction normal to the impinging surface. So that by applying this phenomenon it should be possible to cause a pressure-difference to arise by reason of the heaping-up of molecules in one direction; there being an impoverishment of molecules in the other direction. It was found possible to construct a pump on these lines, employing a smooth cylinder rotating in a close-fitting casing provided with a groove, covering one quadrant of the interior surface of the casing, in the plane of rotation. If the cylinder rotates in a clockwise direction the air in the groove will, in consequence of the gas viscosity, be dragged along, say from a point *n* to a point *m*, a difference of pressure being set up which is proportional to the viscosity and to the speed of rotation of the cylinder. On the casing being exhausted, the pressure-difference between *m* and *n* remains constant in spite of the rarefaction produced, since the viscosity is independent of the pressure. Thus if the pressure-difference is 10 mm. of Hg, at atmospheric pressure the pressure at *m* is 760 mm., and at *n* 750 mm. If the pressure at *m* is reduced to 10 mm., that at *n* ought to be 0 mm.; but this does not occur owing to diffuse reflection at the walls, &c. At pressures below 0·001 mm. the molecules are diffusely reflected from the surface independently of what the angle of incidence may be; and thus, if the cylinder periphery be moving at a velocity greater than the molecular velocity, the molecules in the groove will have a velocity twice as great as the molecular velocity and will be shot off tangentially, whilst no molecules are able to pass in the opposite direction. In practice it was found convenient to give the pump the form shown in the Fig. Here the rotating cylinder, A, is provided with grooves, and the casing B is smooth inside, except for the inwardly projecting portion C. The velocity of rotation is also chosen smaller, and the grooves are arranged side by side and connected in series (like battery cells), that is, *m* with n_1, and m_1 with n_2, &c. Examples are given of the rapidity of exhaustion effected by means of this pump with an ordinary pump for producing what may be called the "pre-vacuum." Thus a Röntgen tube of 1 litre capacity was exhausted down to 15 cm. equivalent spark in 10 sec., starting from 5 mm. of Hg—about ten times as quickly as with the author's rotating mercury pump. The table gives the final pressure (p_1), or vacuum, obtained; p is the initial pressure, or pre-vacuum, and *n*, the number of revs. per min. of the cylinder.



It will be seen that the hitherto unattained pressure of 2×10^{-7} mm. is reached, also that the vacuum is the higher, the lower the pressure in the casing and the greater the speed of rotation. The pump is now made by E. Leybold's successors, of Coeln. L. H. W.

n.	p_1.	p_2.	n.	p_1.	p_2.
12,000	0·05	0·0000002	12,000	20	0·0008
12,000	1	0·000005	6000	0·05	0·00002
12,000	10	0·00008	2500	0·05	0·0008

1609. *Measurement and Automatic Recording of Dead Reckoning.* **F. R. S. Bircham.** (Inst. Naval Architects, Trans. 54. pp. 191–203; Discussion, pp. 203–205, 1912. Engineering, 93. pp. 543–545, April 19, 1912.)—After investigation it was found that the keeping of dead reckoning could be automatically carried out with accuracy, but with certain limitations necessitating hand correction, these limitations being caused by the variables: wind, tide, and currents. Previous inventions are dealt with, and also the requirements for satisfactory automatic recording. The machine now designed by the author, in collaboration with F. G. S. Peile, is arranged for connection to the propeller shaft, either direct to one shaft or through a mean shaft speed-gear. This was adopted owing to the variable inaccuracy of logs or speed indicators, particularly at high speeds. It is possible, by moving a thumb-screw, to instantly correct the ratio of revolutions to miles, the thumb-screw being engraved to show the percentage of distance lost. The course is set by a lever having a pointer working over a dial engraved as a compass. Means are allowed for connecting this lever to a source of power, synchronous with the compass. The lever is easily moved, and the ship's head may be followed with ease. The engraved dial is movable, and is adjustable for deviation and variation. The whole of the calculating gear is positive and mechanical, the revolution-transmitting gear only being controlled electrically, and the electrical gear being of the simplest nature. The course is not recorded unless a printing or plotting attachment is used, as it is deemed unnecessary unless a check is required on the helmsman. It is obvious that, by combination with a clock, the speed can easily be obtained, and, further, that by using N., S., E., and W. counters, the total area covered is apparent; whereas, should two only be used, the final position would appear but not the area covered. Full details of the instrument, with illustrative diagrams, are given. A. W.

1610. *Demonstration of Use of Specific Gravity Balls for determining very small Differences of Density.* **T. H. Blakesley.** (Phys. Soc., Proc. 24. pp. 292–298; Discussion, p. 298, Aug., 1912.)—The author points out that the sensibility of specific gravity balls is 100 times as great as is generally quoted, the error which might be expected in a properly conducted experiment being of the order 5 in the sixth decimal place. L. H. W.

1611. *The Shape of Scales required for Reflecting Instruments with Concave Mirrors.* **E. H. Rayner.** (Elect. Rev. 71. pp. 115–116, July 19, 1912. Abstract of paper read before the Optical Convention, June, 1912.)—For large angular deflections of the mirror, the distance from the reflector to the scale should vary in such a way that the shape of the latter approaches that of the cardioid. For ordinary purposes, however, a circular scale may be constructed which will agree sufficiently accurately with the proper curve. Let u be the distance from the object to the concave mirror of radius a, and θ the angle of incidence; the position of the image is at distance v_θ given by $1/v_\theta + 1/u \doteq 2/a \cos(\theta/2)$. By choosing any convenient value of v_θ, the distance from the mirror to the "centre" of the scale, we can calculate the value of u, knowing the value of a; also the value of a_θ from point to point of the scale. It is then possible to draw a full-sized curve to represent the actual shape which the scale should take. From a point on the curve where it is parallel to the axis of symmetry, a perpendicular is let fall on to the axis and a circle is described having a radius equal to the length of the perpendicular, the centre being the foot of the perpendicular. If the magnification of the mirror is about 1·87 it is found that the circle will touch at the points of the curve corresponding to $\theta = 0$ and $\theta = 60$, and at intermediate points the two curves will not diverge from one another by more than 2 parts in 1000. W. C. S. P.

1612. *A New Machine for Alternating-load Tests.* **B. P. Haigh.** (Elect. Rev. 71. pp. 581–582, Oct. 4, 1912. Paper read before the British Assoc. at Dundee. Electrician, 69. pp. 1063–1065, Oct. 4, 1912. Abstract.)—In this machine the specimen is attached at one end to a laminated spring-supported armature and vibrates over a pole, also laminated, which is excited by an alternating e.m.f. applied to a surrounding coil. A yoke-piece with subsidiary poles makes, with the main pole, a practically closed magnetic circuit, the subsidiary poles allowing just sufficient clearance for the armature. The magnetic pull $F_1 = k(E/c)^2$, where k = const., E = e.m.f. induced in each turn of the magnetising coil, c = cycles per sec. In theory the above relation holds independently of the air-gap, but in practice the leakage flux varies slightly with the gap; this is particularly the case for a small machine such as the present one. The volts for calculating the load are measured on a sensitive voltmeter connected to a coil surrounding the gap. This coil is made of fine wire and is wound very close to the pole-face so as to enclose only the useful flux, the leakage passing outside. In this way the air-gap error is eliminated from the readings. Even though thin stampings effectively insulated are used as laminations it is impossible to avoid some eddy-current loss. This loss varies slightly with the frequency, so that it is necessary to standardise the machine for different frequencies. The armature is supported on flat springs, the large and variable friction of lubricated guides being thus avoided. The lower spring serves to keep the armature central, it being necessary that the side pole air-gaps shall be equal for the lateral stresses to be small. The upper spring is heavier, as it serves also to compensate inertia forces. The stiffness of both springs may be adjusted to suit the frequency by altering the span. The central attachment of the upper spring is also adjustable so that the rest position of the armature may be varied. The springs are correctly adjusted to compensate inertia when the natural period of the mechanical system equals the frequency. The mean value of the magnetic pull is determined by replacing the specimen by a standard spring and increasing the inertia of the system by attaching a comparatively heavy mass to the armature. The standard spring is extended till it lifts the armature, which floats at its normal level, vibrating with only a small amplitude owing to the increased total mass. A consideration of Newton's law shows that the mean magnetic pull equals the pull in the spring *less* the total weight. A number of stress-strain curves are shown for steel wires and are of the usual form. No clear evidence of fatigue is found, though it appears that ductility is not advantageous in withstanding a pulsating load. Hard-drawn wire seems to retain the greatest proportion of its static strength when subjected to pulsating stresses. E. J. S.

1613. *Breaking Tests under Hydrostatic Pressure, and Conditions of Rupture.* **P. W. Bridgman.** (Phil. Mag. 24. pp. 63–80, July, 1912.)—The current theories on the conditions of rupture of materials are briefly known as maximum principal stress, max. shear, and max. principal strain. In the author's experiments hydrostatic pressures of 30,000 atmos. are attained, and he shows for this range the above three theories break down completely. The true criterion of rupture is a much more complicated matter than is usually supposed. The first theory is incomplete because no material can conceivably break down, due to uniform hydrostatic pressure, *e.g.* heavenly bodies. The author's experiments show that all substances tend to become more rigid at high pressures contrary to Kahlbaum, who found increasing density (of most metals) up to 10,000 atmos. and then decreasing density. This anomaly (the author says) is due to the fact that castor oil (which Kahlbaum used) freezes at about 10,000 atmos. Under 20,000 atmos. the author finds paraffin wax as rigid as Bessemer steel. The second theory is discounted by an experiment where a rod is subjected to hydrostatic pressure over its curved surface, the ends protruding through glands the friction of which induces a slight compressive stress. The rod breaks as though by tension. The commonly accepted theory of maximum stress for brittle, and maximum stress-difference for ductile, materials is, the author thinks, untenable. Stout hollow cylinders are subjected to cyclical variations of hydrostatic pressure, and it seems that there is no limit (elastically) to the amount by which the yield-point can be raised. Cylinders of glass made of heavy capillary tubing sealed at both ends will withstand a pressure at 24,000 atmos. without permanent measurable strain. There seems to be some flow and interior adjustment because some of the cylinders broke spontaneously several weeks after the pressure was removed. With glass cylinders stresses are realised 50 times as great as the shear theory would warrant. With metal cylinders subjected to internal pressure the fracture for ductile materials begins at the outside surface and for brittle materials at the inside surface. Striking is the enormous stretching at the inner surface; Bessemer steel giving 175 % and 125 % circumferential elongation, tool steel 120 %, copper 300 %, and lead several thousand per cent. The theory of thick cylinders usually known gives an internal pressure less than the tensile stress, but glass capillaries will actually stand twice the tensile stress. The internal surface of a steel cylinder shows slip-bands and something akin to cold welding, the high pressure keeping the molecules together to resist the induced stress. The author's experiments show an essential difference between brittle and plastic materials, but the distinctions hitherto proposed cannot hold good. The author offers no new theory—his materials are insufficient. H. S. R.

1614. *Tests of Wrought-iron Girders.* **F. P. McKibben.** (Eng. Record, 66. pp. 200–204, Aug. 24, 1912.)—The two girders were 22 ft. long × 29 in. deep × $\frac{5}{16}$ in. thickness of web, stiffened at the ends and at the middle-third points. They had served 30 years in a railway bridge. For testing, roller supports were placed under the ends and equal loads were applied through rollers at the 1/3 points. Strain observations were made on 6 horizontal datum lengths of 40 in. symmetrically placed about the middle section of the beam, and situated respectively in the flanges and symmetrically above and below the gravity-line in the web. Plotting of these results on a space-base shows that in both beams the neutral axis, or axis of zero stress, coincides with the centre of gravity of the beam section up to a certain load. At higher loads the neutral axis rises considerably. Results for one beam, A, justify Navier's assumption of the conservation of plane sections, but the other, B, displays a distinct change at all loads on the tension side, which cannot be traced to experimental error. The flange stress $f = \mathrm{M}_y/\mathrm{I}$, where M = bending moment, y = distance of neutral axis from outer fibre, I = moment of inertia of section. The usual assumption of designers is that $f = \mathrm{M}/h' \; (\mathrm{A} + th/6)$, where h' = effective depth, A = sectional area of flange, t = thickness, h = depth of web. A comparison is made of stresses calculated on these formulæ, and from observed values of strains and of Young's modulus. It is found that the approximate formula is closely confirmed by experiment. The observed centre deflections differ inappreciably from those calculated on the exact formula in which account is taken of shear flexure, and variations in cross-section along the flanges. The variations from the more approximate theory are slight. Deflections remained elastic in both beams up to 59 per cent. of the ultimate loads. Beam A failed by lateral buckling of the compression flange at the middle of the span, the web also buckled under shear at the outer ends. Rusty laminations were observed at the point of failure. Beam B failed by tearing of the tension flange, laminations being again evident. The top flange showed damage at quite low loads, indicating that a rivet pitch of 6 in. and edge distance of 4 in. are too large with $\frac{3}{8}$-in. plate. The stiffeners were carelessly made, being too short. That they should be long enough to stiffen the flanges is shown by buckling of the latter at the loading points. E. J. S.

1615. *A General Formula for the Torsional Deflection of Shafts.* **S. E. Slocum.** (Frank. Inst., Journ. 174. pp. 83–89, July, 1912.)—In a previous article [see Abstract No. 720 (1911)], by considering the internal work of deformation, the author derived a general formula for the shearing deflection of beams of arbitrary cross-section, variable or constant. At the same time a modified Fraenkel formula for flexural deflection was obtained. It was shown that all the usual flexural and shear deflection formulæ are special cases of the two general formulæ obtained. The present article completes the investigation by the application of the same methods to torsional deflection. The general formula for a prismatic shaft reduces to the form—

$$\theta = \frac{l}{\mathrm{GT}} \int_0^{\mathrm{A}} q^2 d\mathrm{A},$$

where θ = angle of twist due to an applied torque T, l = length of shaft, G = modulus of shear, q = shear stress due to T, and A = cross-sectional area of shaft. This expression being a surface integral, becomes a double integral when applied to rectangular co-ordinates. The author considers fully the cases of circular, triangular, and rectangular sections. E. J. S.

1616. *The Graphical Construction of Bending-moments on Short Girders.* **T. Alexander.** (Roy. Irish Acad., Proc. 30. 2. pp. 16–41, Aug., 1912.)—A 5-wheel locomotive is considered and for the sake of simplicity the total weight and the span are represented by the same number. The diagram of maximum bending-moments resolves itself into a series of intersecting parabolic arcs. The vertical axes are placed about the middle point of the span in the same way as the wheels are placed about the centre of gravity of the locomotive, but at half the distance in each case. The 5 loci, in common with a sixth for the total weight rolling on one wheel, have their heights numerically equal to the squares of their half-bases. The junctions of the fields governed by each wheel can be calculated. Thus the whole diagram can be drawn by means of a parabolic set-square of the same shape as the 6th (easily determined) locus, by placing it in the appropriate positions. A template of convenient dimensions is made by altering the vertical scale of foot-lbs. A method is elaborated for drawing the 5 loci without considering the junctions of the fields, which depends on the fact that the depths of the junctions of the parabolic arcs in pairs below the 6th parabola are given by the moments of the weights of the wheels about their common centre of gravity. Each arc is raised and distorted obliquely to coincide with the 6th locus, the bending-moment diagram becoming the 6th parabola minus a rectilinear diagram over the span. The latter polygon is that due to a set of upward fictitious forces at the junctions of the fields whose magnitudes are numerically the same as the distances between the wheels multiplied, in the general case, by the ratio of the weight of the locomotive to the length of the span. The application of this single-parabola method to the case considered is described, as are the cases of spans accommodating any portion only of the locomotive. The parabola used is of modulus unity, the proper scales being used, and is such that the height at each point equals the product of the segments into which it divides the base. A consideration of Euclid 2, 14 leads to the use of circular arcs described from centres set off about the centre of the span, at half the distances at which the wheels stand from the centre of gravity of the locomotive. The resulting diagram represents the square root of the true bending-moment diagram. Both the graphical methods described enable the maximum of maximum bending-moments to be located precisely, but Culman's ordinary method of moving the span about within a diagram for one position only enables the location to be made approximately by trial and error. The third graphical method discussed is an application of the circular arc to Culman's, whereby the latter is made precise.

A kinematical model is described, in which a model locomotive travels over the span, operating links which show how the vertices of the bending-moment polygon describe parabolas during the passage. The paper is illustrated by full diagrams to scale. E. J. S.

1617. *Suction between Vessels.* **A. H. Gibson** and **J. H. Thompson.** (Engineer, 114. pp. 313–314, Sept. 20, 1912. Paper read before the British Assoc., Dundee.)—The experiments described were carried out in the Firth of Tay with a view of obtaining some information as to the magnitude and range of action of the forces involved in the case of "suction" or inter-action between passing vessels. Two screw-propelled vessels were used, one, the S.Y. *Princess Louise*, 88·5 ft. long, 13 ft. beam, 5·66 ft. mean draught, displacement about 96 tons; the other, a motor launch, 29·83 ft. long, and 6·75 ft. beam. Two sets of experiments were carried out. In the first the vessels were manœuvred until on sensibly parallel courses, heading for the same distant object, their lateral distances apart and speeds being varied in different experiments. The courses having been satisfactorily fixed with the helm of the motor boat amidships, this helm was lashed, the helm of the *Princess Louise* being afterwards manipulated so as to keep her on her original course. The second series of experiments was carried out with a view of measuring the helm angle required to maintain the course of the smaller when in the vicinity of the larger vessel. In these experiments the relative positions of the two boats were obtained as in the first set of experiments, the helm being adjusted as required to keep the head of the vessel on its original course. The experiments are described in full detail in the paper, and diagrams exhibited showing the relative paths and positions of the two vessels under varying speeds and in different relative positions. The general conclusions deduced from the experiments are as follows:—The greater the difference between the speeds of the vessels the smaller is the risk of collision, since such a difference reduces the time during which the mutual forces are operative, such an effect being much more marked when the smaller vessel is the faster. But if the larger vessel is the faster, and particularly if her speed is accelerated while passing the smaller, the attractive forces are increased to an extent which partially, and in some cases entirely, counterbalances the effect of the reduction of the time during which the vessels are in dangerous proximity. It follows that any attempt of the larger vessel to draw ahead of the smaller by increasing her speed greatly increases the risk of collision. On the whole the results of the trials show that, under unfavourable circumstances, inter-action is a very real danger to navigation, even in deep and open waters. With vessels of the relative sizes adopted for the experiments, if the possibility of inter-action is realised from the very first, and if all initial swerve is prevented by an early application of the helm, there would appear to be little danger even at lateral distances so small as one-half the length of the smaller vessel, but if this possibility be not realised, and such a swerve has once been initiated, a much greater helm angle is necessary to control the vessel, and, failing immediate control, collision occurs within comparatively few seconds even from astonishingly great distances. The importance of this fact is more readily grasped when it is realised that with a vessel of, say, 800 ft. in length, passing a vessel of, say, 900 ft. in length, the forces of inter-action have to be reckoned with even when the vessels are 1000 ft. apart laterally, which would ordinarily be considered to be giving the larger vessel a very wide and safe berth. A. W.

1618. *The Equation of Energy in Rotating Fluid.* **R. Liljeblad.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1510–1515, Sept. 14, 1912.)—The object of the author is to criticise the work of D. Banki against the truth of the Bernoullian equation. Using vectorial methods, the author shows that Bernoulli's equation is true for every point in one stream-line, and in the case of irrotational motion it is true for every point. A discussion of fluid motion in bends is given, and it is shown that an enlargement of section must occur at the bend, and a consequent transformation from kinetic to pressure energy. D. Banki replies to Liljeblad's criticism by denying anything new to it, and brings other arguments to support his former contentions: (1) that Bernoulli's equation is not true for a deflected stream or streamline; (2) that the velocities in bends are invariable, *i.e.* that the existence of a force potential does not determine the existence of a velocity potential; (3) that stresses and pressures caused by centrifugal action do not increase the pressure energy. Why these are so different from the results of conventional hydrodynamics is that the latter deals with accelerating forces in the direction of the stream-line. Banki reasons from experiment, and shows that the equations of Bernoulli derived by hydrodynamics are quite inapplicable to technical purposes. He gives illustrations of two velocity models which he has constructed, showing the variation of velocity across a section of straight and curved pipe. In a pipe bend there seems to be vigorous interchange of the streams, the region of highest speed passing from the centre of the straight pipe to the outside curve of the bend. H. S. R.

1619. *Effect of an Internal Free Fluid upon the Stability of Ships.* **A. Cannon.** (Inst. Naval Architects, Trans. 54. pp. 124–139; Discussion and Communications, pp. 139–144, 1912.)—Instead of using the method generally given in text-books, namely, considering the water as an added weight, the author considers the water as a loss of buoyancy, which method is applicable here, where the density of the internal fluid is the same as that of the external fluid. The calculations made concern (1) a rectangular box-shaped vessel; (2) a vessel of triangular section, floating with vertex downwards; (3) a vessel of parabolic section, floating with axis vertical and vertex downwards; (4) a ship-shaped form (182 ft. long, 27 ft. breadth, 600 tons displacement). The result in the last case is similar to that obtained in the preceding cases. The conclusion is arrived at that, with free water in a ship, the *initial* stability is a maximum when the level of the water inside and out is *the same.* The stability at large angles is next investigated, and in this case it is found that the *best* depth for *initial* stability is the *worst* case for *stability at large angles*, and also that at all depths less than this the stability is the greater, the less the depth. In the written communications, **J. H. Biles** pointed out that the results were very curious and, so far as he was aware, new. In the case of a water-logged ship, the water inside naturally tends to reach the level of the water outside: as the GM is a maximum, it will be more difficult to incline her than in any other condition of flooding. On the other hand, if she is inclined she will be in the worst case for capsizing, because the stability at finite angles is a minimum. He considered that the investigations may have a high value, as the case is in some degree analogous to that of a battleship when damaged. L. H. W.

1620. *Lecture Experiments for Demonstrating Flow of Liquids through Tubes.* **U. Bordoni.** (N. Cimento, 4. Ser. 6. pp. 5–30, July, 1912.)—Employing a horizontal tube, one end of which is slightly enlarged and attached to a siphon of larger bore, the other end being open, and gradually raising the level of liquid entering the siphon, the jet issuing from the open end of the tube alters its form, corresponding to a change from the Poiseuille regime, in which the velocity of flow is proportional to the pressure, to the "hydraulic" regime, in which the difference of pressure increases as the square of the velocity. The phenomenon may be observed with mercury as well as with water. In the former case the tube should have a diam. of 1/3 to 1¼ mm., and be at least 300 diams. in length. The head of mercury required to reach the transition-point increases as the diam. of the tube is reduced, being about 15 cm. for a 1-mm. tube, and about 50 cm. for a tube of 1/3 mm. bore. With water, tubes 2 to 5 mm. diam. and 80 to 200 cm. long should be used, the head of water required to produce the change being, for a 3·5-mm. tube, about 150 cm. From mathematical considerations it is concluded that when the velocity of flow is 100 cm. per sec., the phenomenon would be best observed with the tube inclined upwards at an angle of 60° with the horizontal. If a portion of the downward arm of the siphon is replaced with a piece of indiarubber tube about 30 cm. long, a jerking may be observed in the indiarubber tubing, accompanied by a slight noise, at each change in the form of the issuing jet of liquid. W. H. Si.

1621. *Origin of Small Bubbles of Froth.* **J. A. Pollock.** (Phil. Mag. 24. pp. 189–196, July, 1912. From a paper read before the Roy. Soc. of New South Wales.)—The object of the investigation was to find the origin of the small bubbles which constitute the characteristic feature of the froth which is produced by violent agitation. The froth is readily created when gas under pressure is forced into a liquid through the orifice of a vertical pipe. To study the conditions of formation instantaneous shadow photographs were taken of a jet of gas in various solutions, seven such being reproduced in the paper. By inspection of the photographs it was found that the bubbles may be divided into three classes: (1) Large bubbles formed by partition of the main bubble continuously formed at the pipe end. (2) Small bubbles formed from protuberances on the large ones. (3) Still smaller bubbles occurring only in cases of violent agitation of oil-contaminated liquids or of solutions capable of frothing. E. H. B.

1622. *Flow of Mercury along Tinned Copper Wires.* **A. Tcherniawsky.** (Archives des Sciences, 34. pp. 32–55, July, 1912.)—In order to pass an electric current between two vessels of mercury situate at different altitudes, the two quantities of mercury were connected by means of a tinned copper wire coated with rubber. It was found that the mercury passed from the upper to the lower vessel along the wire as though the latter were a siphon. The insulating covering of the wire is necessary only to prevent oxidation of the tin, the nature of the coating being of no importance. The mercury appears to flow between the tin and the insulation, and it was not found possible to obtain corresponding results with two different, although apparently exactly similar, wires under identical conditions. Under the experimental conditions employed the flow of the mercury is independent of the head of mercury for values of the latter up to 650 mm. The phenomenon seems therefore to be a capillary, chemical (amalgamation) or diffusion effect. In order that this flow of mercury may take place it is necessary for amalgamation to occur, but such amalgamation by the progressive diffusion of the mercury is complicated by a surface or capillary action. The amalgamation seems to be limited to a very thin surface layer, it being found that tinned iron wires exhibit similar behaviour to those of tinned copper. T. H. P.

1623. *Modes of Rupture of an Open Hemispherical Concrete Shell under Axial Pressure.* **J. R. Gwyther.** (Manchester Lit. and Phil. Soc., Mem. 56. 9. pp. 1–8, 1911–1912.)—The specimens were all of the same concrete, made and dried under the same conditions and tested at the same age. Each shell was in the form of a dome; the base was the equatorial plane of the enveloping spheres and the top was a plane parallel to the base. In all but the smallest specimens the mechanism of failure is substantially the same. Under a considerable compressive load longitudinal cracks appear in meridional planes starting from the base and rising slowly to about 2/3 of the height; at this point a latitudinal crack appears and the dome breaks on a section which appears to be approximately a conical surface whose apex lies nearly on the centre of the sphere. Since concrete has but slight tensile strength it is concluded that the slow growth of the initial meridional cracks indicates that the "ring tension" set up is small. With the exception of the smallest specimen, which failed by meridional cracks alone, the failures have occurred for the same load, not the same stress. This leads to the conclusion that the usual assumption of failure by shear is not justified, but that failure is due to an excessive "bending moment" due to the resultant stress on the section acting outside the middle third. The theory of "angle of rupture" does not apply to an externally applied load and is probably also inapplicable to a concrete dome under its own weight. The effect of reinforcing with one or more wires at the base is to cause the initial cracks to start from the top. Failure follows after the same manner as before, though at greatly increased loads. With shells reinforced at top and bottom the resistance is still more increased. The meridional cracks start at the middle and extend either way; when they have nearly reached the reinforcements failure suddenly occurs along a roughly meridional plane. In some cases the shell practically collapsed all over. Further experiments are foreshadowed to investigate the probably great effect of varying the position of the reinforcements. E. J. S.

1624. *Cellular Vortices.* **C. Dauzère.** (Comptes Rendus, 155. pp. 894–898, Aug. 5, 1912.)—Previous experiments have been described giving the formations produced by heating thin layers of wax with imprisoned water-vapour [Abstract No. 1154 (1912)]. Now further investigations are summarised showing the variations introduced into the form of the cellular vortices by higher temperatures than 120° C. Later work is also described showing the striking changes produced in the cell arrangement by higher temperatures. The chief feature is the great augmentation of the size of the cells, and this is also accompanied by certain modifications of the general network, and a loss of the regular outline exhibited by the smaller units. A detailed description is given of the phenomena during the progress of transition between the two types. C. P. B.

1625. *The William Froude National Tank.* II. **G. S. Baker.** (Inst. Naval Architects, Trans. 54. pp. 58–63; Discussion, pp. 63–67, 1912. Engineering, 93. pp. 418–420, March 29, 1912.)—Gives structural details and some particulars of still-water experiments. [For Part I. see Abstract No. 289 (1912).]

1626. *Exact Determination of the Constants of Empirical Formulæ.* **M. E. J. Gheury.** (Engineer, 114. pp. 267–268, Sept. 13, 1912.)—The author shows how to obtain an interpolation formula of the form $y = ax^3 + bx^2 + cx + d$ to express experimental results, and illustrates by several examples how it can be usefully applied. A. R.

1627. *Determination of the Stresses in Springs by Optical Methods.* **E. G. Coker.** (Engineering, 94. pp. 404–405, Sept. 20, 1912. Paper read before the British Assoc. at Dundee.)—The author in the present paper shows how the optical method of measuring stress [see Abstracts Nos. 296, 297 (1911), 776 (1912)] lends itself to the investigation of springs. L. H. W.

1628. *The Formal Specification of the Elements of Stress in Cartesian, and in Cylindrical and Spherical Polar Co-ordinates.* **R. F. Gwyther.** (Manchester Lit. and Phil. Soc., Mem. 56. 10. pp. 1–13, 1911–1912.)—The paper is prefatory to further work. Instead of an initial assumption of Hooke's law, the author solves the equations of stress as a first step. These equations are then conditioned so as to be able to satisfy the surface tractions. Lastly, the question whether the solution can be made to satisfy Hooke's law is taken as the final condition. E. J. S.

1629. *Accidental Deviations of Density in Mixtures.* **L. S. Ornstein.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 54–64, June 25, 1912.)—

The author points out that the theory of accidental deviations of density in mixtures does not differ, so far as the principles are concerned, from that of the deviations of density in systems containing only one kind of molecules. In order to calculate these deviations he applies the canonical ensembles of Gibbs. Unsuitable for abstraction. L. H. W.

1630. *Smoluchowski's Hydrodynamical Theorem.* **C. W. Oseen.** (Ark. för Mat., Astron. och Fysik, Stockholm, 7. 33. pp. 1–9, 1912.)—Highly mathematical paper relating to the parallel motions of two spheres in a viscous liquid. E. H. B.

1631. *Kinetic Properties of a Molecule in a Substance.* **R. D. Kleeman.** (Phil. Mag. 24. pp. 101–118, July, 1912.)—The author gives a further discussion of the question as to whether the kinetic energy of a molecule in a liquid is the same as that in a gas at the same temperature, the discussion being based on the hypotheses mentioned in Abstract No. 1172 (1912). It is concluded that the average velocity of a molecule in a liquid may be several times that corresponding to its temperature. A general formula is deduced for the coefficient of viscosity for matter of any density. General formulæ are also given for the coefficients of conduction of heat and of diffusion. (Cambridge Phil. Soc., Proc. 16. pp. 631–642, July 24, 1912.)—An extension of the paper dealt with above. E. M.

1632. *Vortex Motions in the Atmosphere.* **J. W. Sandström.** (Ark. för Mat., Astron. och Fysik, Stockholm, 7. 30. pp. 1–33, 1912.)—The theory of vortex motion is explained in outline, and drawings are given of the forms of vortex lines in simple cases, *e.g.* air rotating inside a tube; rotating earth and atmosphere; tornado. Numerical computations of the "circulation" in each case are explained. The author considers that vortices in the atmosphere belong in general to one of two kinds: rotating vortices, in which the vortex lines are nearly vertical; and "gliding" vortices, in which they are nearly horizontal. The former are nearly circular and symmetrical, a fact which renders easy any computations of circulation in their case. The latter are not symmetrical, but there is a "gliding" plane dividing the air concerned into two parts. The plane is usually inclined to the horizontal, and the air above it is humid and of a higher temperature than the dry and heavier air below it. The motion of the upper current is generally in a different direction and of a different magnitude from that of the lower. A mathematical determination is made of the circulation for gliding vortices, and it is converted into a form suitable for application to given examples such as thunder squalls. The method is further developed to show how the energy of a steady vortex motion of the same kind can be determined. Thus, off the west coast of Norway a dry, cold, east wind is often experienced, bounded in the upper air at a height of about 1000 m. by a gliding surface above which a lighter west wind prevails. The east wind is an example of the conversion of heat energy into the kinetic energy of wind, and it is computed that energy is so transformed per 500 km. of coast-line at a rate equivalent to 22,500 millions of horse-power. R. C.

1633. *Atmospheric Pressure and Temperature.* **W. Brockmöller.** (Archiv. d. deutschen Seewarte, Nos. 4 and 5, 1911. Nature, 90. p. 94, Sept. 19, 1912.)—Brockmöller deals with the geographical distribution of the monthly range of oscillation of the barometer. This range is the mean value of the difference between the highest and lowest readings for each month.

Charts (not reproduced in "Nature") are given showing the lines of equal range. In the northern hemisphere the range is least, 3 or 4 mm., in the equatorial region and greatest near the Arctic Circle, apparently diminishing again towards the pole. **Köppen** and **Wendt** (Ibid.) discuss the vertical distribution of temperature over Hamburg between the earth's surface and a height of 8000 m. 1200 ascents have been dealt with, made during the years 1904–9. Special notice has been taken of inversions of temperature. These were found in 69 out of every 100 ascents for the whole series. In the month of December they occurred in nearly every ascent. Inversions exceeding 3° C. were almost invariably accompanied by a decrease in relative humidity. It was found that near the surface the temperature gradient was greatest with north winds, above 500 m. with west winds, and above 1000 m. with southwest winds. J. S. Di.

1634. *Diurnal Range of Temperature on the Obir.* **A. Defant.** (Meteorolog. Zeitschr. 29. pp. 263–272, June, 1912.)—The Obir is a mountain-peak 2141 m. high, situated in Austria to the south of the Carinthian basin. The results in the paper are from observations covering the 8 years 1892 to 1899. The max. temperature of the day occurs on the average at from 2 to 3 p.m., being slightly earlier in winter and later in summer. The minimum occurs at 6 to 7 a.m. in winter, and 4 a.m. in summer. The daily range varies from less than 1° C. in winter to 3·6° C. in summer, the mean for the year being 2·1° C. These ranges are less than the corresponding values for Sonnblick, which is 3106 m. high. An investigation of the diurnal variation of temperature on clear and dull days shows that the amount of the variation is appreciable (about 4° C.) on the former, and small (about 1·3° C.) on the latter. On clear days temperature begins by being relatively low. At sunrise it commences to increase, and gradually attains its maximum at 4 p.m., after which it falls to a value at midnight considerably greater than that at the beginning of the day. On dull days the final value on the contrary is lower than the initial one. Temperature falls to a minimum at from 6 to 8 a.m., then rises to a maximum at 2 p.m., and thereafter falls steadily. Similar changes occur also at Sonnblick, and they appear to be characteristic of mountain stations, for at Vienna they are either imperfectly shown or actually reversed. Following Trabert, the author seeks to explain them by supposing that anticyclones, which are often associated with clear weather, produce a descent of air which brings about mechanical heating, while conversely the cyclonic character of dull days is accompanied by an ascent of air, producing a cooling effect. A calculation shows that the mean rate of descent of air to produce the observed heating effect on clear days is 14 m. per hour. [See also Abstract No. 782 (1899).] R. C.

1635. *The Free Atmosphere in the Region of the British Isles.* **W. H. Dines** and **W. N. Shaw.** (Meteorological Office, Geophysical Memoirs, No. 2. pp. 13–50, 1912.)—The results of *ballon sonde* ascents both in England and on the Continent are dealt with statistically by W. H. Dines, using the methods of correlation. The quantities considered are (1) pressure at sea-level, (2) mean temperature of the air column from 1 to 9 km., (3) pressure at 9 km., (4) height of the troposphere, and (5) temperature of the stratosphere. Total correlation coefficients between each pair of these quantities are given, and the following general results are obtained :—(1) Pressure variations at 9 km. are nearly the same as the simultaneous pressure-variations at sea-level; (2) high pressure at sea-level is usually associated with a high mean temperature of the column, with a height of the troposphere greater than usual, and with a low temperature in the stratosphere. Inasmuch as some of the quantities considered are connected by hydrostatic relations, it is evident that high total correlation coefficients must exist between some pairs of them, and this fact renders it difficult to discriminate between the influences which each member of such a pair exerts upon a third variable. These influences can, however, be investigated by using partial correlation coefficients, and Dines gives in detail many of these, and discusses their significance.

In a preface W. N. Shaw deals with some applications of two of the relations established by Dines, viz.: that pressure variations at sea-level and at 9 km. are simultaneous and practically equal to one another, and that high pressure at sea-level is associated with a high mean temperature up to 9 km. The surface pressure is equal to the pressure at 9 km. together with that due to the column below the 9-km. level. Since variations at sea-level and at 9 km. are nearly identical it follows that the contribution towards the surface pressure due to the column is nearly constant, any increase of temperature being compensated by an increase of pressure, so as to keep the mean density unchanged. This confirms the view that depressions in temperate latitudes are not caused by columns of warm air, nor are moving anticyclones produced by columns of cold air. Again, since simultaneous pressure-changes are the same at 9 km. as at sea-level, the main features of consecutive changes of pressure and of its geographical distribution are the same at the two levels, and therefore the changes of pressure at the surface are due to similar changes brought about in some way at 9 km. Also it follows that barometric gradients at the two levels are equal. The conception of pressure-changes at the surface as due to similar changes at 9 km. leads to a simple explanation of some forms of clouds. The lowering of temperature of the column of air due to diminished pressure at 9 km. is most marked at the 9-km. level, and as the air must be nearly always saturated at that level a steady fall of pressure will gradually develop a high cloud of the cirrus type. If the pressure continues to fall the cloud grows downwards and gains in density, but, owing to a difference in the behaviour of dry air and moist air, instability will be set up, and the cloud will tend to rise, forming cirro-cumulus, alto-cumulus, or even cumulus clouds. Illustrations of the gradual formation of such clouds are reproduced. A difficulty in the application of the above conclusions is that in our latitudes, east winds at great heights are infrequently observed, whereas winds from any direction should be just as frequent as at the surface if pressure distribution remains unaltered as one ascends. This point is discussed, and certain results obtained from pilot balloons observed by C. J. P. Cave are quoted to show that, so far as the W.-E. component is concerned, the surface wind is in general obtained from that at 9 km. by adding to the latter continuously as one descends an easterly velocity. Thus if there is an East component at 9 km. there will be a stronger East component at the surface; if there is a West component at 9 km. the surface wind will have a smaller West component, or it may even be reversed and become easterly. [See also Abstract No. 998 (1911).] R. C.

1636. *Cyclones and Anticyclones, or Regions of Falling and Rising Pressure?* **W. Trabert.** (Meteorolog. Zeitschr. 29. pp. 197–201, May, 1912.)—The distribution of pressure over an area is viewed in two ways by two different schools of meteorologists. The view more generally entertained is that cyclones and anticyclones are the original entities; the other view is that the moving cyclones and anticyclones are perhaps not self-contained, but that the regions of rising and falling pressure are the original units into which the area may be divided. Work done by Ekholm (isallobars), Exner, Trabert, and Defant is mentioned in support of the second view. Hann, Wagner, and Dines have shown that cyclones and anticyclones are respectively cold and warm on the average—a fact which disproves the old theory of the formation of these systems. Trabert maintains that it is now demonstrated that warm and cold columns of air are places where pressure is falling and rising respectively, and that such columns are at least as real as cyclones and anticyclones. The great action-centres are not included among the cyclones and anticyclones referred to. The latter are due to comparatively small travelling variations superposed upon the average pressure-distribution. R. C.

1637. *Temperature in the Free Air over Batavia.* **W. van Bemmelen.** (Meteorolog. Zeitschr. 29. pp. 305–308, July, 1912.)—The following general results are obtained from *ballon sonde* ascents covering the last two years. Temperature at all levels in the free air up to 14 km. is higher in the rainy season (Oct.–March) than in the dry season (April–Sept.), the difference being 2° or 3° C. at the higher levels. The variations from the mean temperatures are much greater during the rainy than the dry season, differences between recorded extremes varying from 6° C. to 17° C. at different heights during the former season, and from 3° C. to 10° C. during the latter. The mean temperature of the column diminishes with increasing height up to 16 km., where it is —78·4° C. Above that level observations are not sufficiently numerous to give a reliable mean. Temperature gradient has maxima of 0·91° C. per km. at 9–10 km., and 0·95° C. at 12–13 km., and minima of 0·53° C. at 3–4 km. (the cloudy layer) and 0·36° C. at 11–12 km. (cirrus level). The gradient at 15–16 km. is only 0·13° C. per km., so that the stratosphere is probably not far from that level on the average. The few observations of temperature in the stratosphere give the following means: April–Sept., — 78·6° C.; Oct.–March, — 81·1° C. R. C.

1638. *Periodic Variations of Lake-levels and of Climate.* **O. V. Johansson.** (Meteorolog. Zeitschr. 29. pp. 257–262, June, 1912.)—In order to investigate variations having definite periods of different lengths, A. Wallen uses a method whereby the variations are successively detected and eliminated, beginning with the one of shortest period and proceeding in turn to those of longer periods. Thus, starting from monthly values, he eliminates the annual variation by taking the mean of every 12 consecutive months and dealing with the series of smoothed values so obtained. By counting the number of maxima and minima in the curve obtained by plotting the smoothed values and noting the total time represented by the observations, the next shortest period is approximately determined, and it is eliminated as before by forming the mean of every consecutive series of values covering that period. Thus Wallen, in considering the variations of level of the Vänern Lake in Sweden found a period of about 3¼ years, and this was eliminated from the smoothed observations obtained after the elimination of the annual variation, by forming means from every successive set of 40 monthly values. The variations of any period are isolated by subtracting the set of values, from which the period has been eliminated from the preceding set. Wallen thus investigated periods of 1 year, 3¼ years, two of 11·4 years, and others. The amplitude of one of the 11·4-year periods is larger than that of the other. Both periods correspond closely with that of sun-spot frequency. A similar analysis of precipitation shows that maxima in Sweden occur very shortly after the extreme values of sun-spot frequency, the minima occurring some years later. The corresponding extremes of lake level and temperature fall about a year later than those of precipitation. The author has made a similar investigation of the Helsingfors records from 1829 to 1911, and he finds that, in general, the minima of temperature, rainfall, and cloudiness at that station occur at the times of maximum and minimum sun-spots, the maxima being 2 or 3 years later. A similar analysis of crop records for Finland reveals the existence of an 11·4-year period, with the Brückner period of 35 years (= 3 × 11·4 nearly) superposed, and also shows indications of a subsidiary period of 3·8 years. There is a tendency for years of bad harvests to occur at the time of minimum sun-spots. R. C.

1639. *Variation of Latitude.* **Albrecht.** (Astronom. Nachr. No. 4588. Nature, 89. p. 512, July 18, 1912. Abstract.)—A summary is given of the provisional results obtained by the International Latitude Service in 1911. The curve is given from 1906, and it appears that the max. deviation has now occurred, the spiral showing signs of closing in again. C. P. B.

1640. *Determination of Seismic Epicentres.* **B. Galitzin, G. W. Walker.** (Nature, 90. p. 8, Sept. 5, 1912.)—In a previous paper [Abstract No. 1328 (1912)] it is shown that, as a Galitzin installation gives both the distance and azimuth of the epicentre, that point is uniquely determinable. The authors here point out the fact that if the azimuths of the epicentre are observed at two independent stations suitably situated, the epicentre can be determined from these two azimuths alone. This method has the following advantages: (1) It is independent of any time reckonings, (2) it does not involve the often difficult observation of the second phase S on a seismogram, (3) it is independent of any empirical time-distance tables, and (4) the determination is unique although only two stations are used. A. D. R.

1641. *Brightness of Sky near Sun.* **H. Diercks.** (Phys. Zeitschr. 13. pp. 562–564, June 15, 1912. Extract from Dissertation, Kiel, 1912.)—Measurements made at various distances, tabulated in degrees and minutes, from the east and west limbs of the sun, giving the relative brightness of the atmospheric illumination. C. P. B.

1642. *Brightness of Midnight Sky.* **W. J. Humphreys.** (Astrophys. Journ. 35. pp. 273–278, May, 1912.)—An attempt made some years ago by Newcomb to determine the total light of all the stars gave a result far from being in accord with expectations, especially with regard to the relative brightness of the galactic and non-galactic portions of the sky. Recent work by Yntema in Holland suggests that there is a factor depending on earth light, which is only partly reflected star-light, the extra illumination being possibly due to permanent aurora. Abbot, working on Mount Wilson with a Kapteyn sky photometer similar to that used by Yntema, obtained results in fair agreement but smaller in amount. This suggests that the phenomenon of earth-light is characteristic of the high atmosphere, and fairly general as to time and place. In the present paper the author discusses another possible source of illumination, viz., the continual bombardment of the outer atmosphere by meteoric material. He calculates that the fall of about 8 kg. per second would be sufficient to explain the energy demanded by Yntema's value of the earth-light. C. P. B.

1643. *Constitution of Solar Corona.* **J. W. Nicholson.** (Roy. Astronom. Soc., M.N. 72. pp. 677–692, June, 1912.)—In a previous paper [Abstract No. 449 (1912)] it was shown that a large part of the coronal spectrum can be interpreted in terms of the vibration of an elementary substance called protofluorine, to which a definite atomic structure was assigned. The analysis begins with the adoption of Planck's atomic structure notation [Abstracts Nos. 497 (1900), 341 (1912)], and gives a full treatment of the spectra of neutral and positively-charged atoms of protofluorine. It is pointed out that an expulsion or retention of an electron by any atom probably involves a discontinuous change in the angular momentum of the atom, which is dependent on the number of electrons already present. The lines due to neutral or positively-charged atoms are λλ5073, 4586, 4811, 4231, 3987, 3800·9, 3387·9. All other lines of protofluorine in the spectrum must be due to negatively-charged atoms. C. P. B.

1644. *New Nebula Line at λ4353.* **J. W. Nicholson.** (Roy. Astronom. Soc., M.N. 72. p. 693, June, 1912.)—The line predicted from electronic analysis as belonging to the nebular spectrum was found by Wright in a specially well-exposed photograph of the Orion nebula. It has also been found by M. Wolf on a photograph of the spectrum exposed for 40h. 48m. between Jan. 20 and Feb. 28, 1912. The wave-length in the nebula spectrum is 4353·9. On the Lick Observatory plate it was 4353·3. Both these values are, of course, affected with the motion of the nebula. C. P. B.

1645. *Movement of Vapours in Solar Atmosphere.* **A. Perot.** (Comptes Rendus, 154. pp. 1684–1686, June 17, 1912.)—Different values are found for the velocity of descent of absorbing vapours in the sun's atmosphere, varying from 1·37 km. per sec. for sodium to 3·8 km. per sec. for hydrogen. Iron vapour gives practically no velocity of movement under similar circumstances. Comparing these values with the excess equatorial velocities, a correspondence is indicated which suggests the influence of the molecular velocities under electrical action, possibly identical with the source of the magnetic field in spots. C. P. B.

1646. *Sun-spots and Terrestrial Magnetism.* **C. Chree.** (Roy. Soc., Phil. Trans. 212. pp. 75–116, July 10, 1912.)—That a relationship exists between the phenomena of sun-spot activity and terrestrial magnetism has been known since the investigations of Sabine, Lamont, and Wolf during the last century. Various papers by the present author have shown the degree in which the data run together, according to the method of reduction employed. An important result was that no difference was found for the mean sun-spot frequency from all days and from "quiet" days only. This negative result was slightly modified when it was found that on separating the sun-spot disturbances into groups according to area there appeared to be some indication that the groups of days of largest sun-spot areas contained fewer "quiet" days and more "disturbed" days than the groups of days of smallest spot areas. Following up the idea of Arrhenius that the magnetic effects may be due to electrified particles emanating from the sun, and thus introducing a time lag between cause and effect, it is shown that the time taken for the transference must vary from less than 1 to more than 3 days. Most of these results were obtained by discussing the observations of 11 years as a whole, and if individual years were taken separately the coincidences are sometimes in opposite phase; thus for 1895 there was an apparent association of large D ranges with small spot areas. This showed the necessity for more detailed analysis of all the data, and the present paper summarises the results of such recent work. An increase of sensitiveness was obtained by substituting observations of H ranges for the D values previously employed. Another method was by using the "character figures" instead of the H ranges. The general result is that mean annual ranges of absolute H do not vary with sun-spot frequency as closely as do the diurnal inequality ranges. This points to the conclusion that the magnetic wave, lagging some 4 days after the sun-spots, represents only a part of the sun-spot influence. In addition there seems to be an influence which maintains a high average range of diurnal variation in years of many sun-spots, so that even when sun-spot area for several days in succession falls to a comparatively low level, the daily range continues to exceed that normal to the same month of a year having the same mean sun-spot area as the specified days. There is also a more distinctively disturbance element whose amplitude does not appear to be directly proportional to sun-spot area, and which seems largely responsible for a 27–28-day period. It is mentioned that sun-spots may not be the actual sources of the solar influence. C. P. B.

1647. *Solar Prominence of June* 19–20, 1911. **F. Slocum.** (Astrophys. Journ. 35. pp. 301–303, June, 1912.)—Thirty-four photographs of this interesting prominence were made with the Rumford spectroheliograph of the Yerkes Observatory, and a detailed description is given of the chief changes shown on the plates. The height of the prominence on the 19th of June was 97,000 km., and its extent along the limb about 190,000 km. It extended from latitude + 35 to + 49° on the west limb. When first observed three conspicuous features were noticed: the arch on the left, the pillar in the centre, and the lofty extension on the right. Many of the photographs are reproduced, and clearly illustrate the very rapid changes undergone by the eruptive matter. After passing through many transformations the prominence finally floated away upward and disappeared. C. P. B.

1648. *Terrestrial Absorption of Solar Radiation.* **J. Vallot.** (Comptes Rendus, 155. pp. 332–333, July 22, 1912.)—Observations of the solar constant at Chamounix (672 mm. press.) and on the summit of Mont Blanc (448 mm. press.), gave a difference of 0·3 calorie. If it were not for the complications introduced by the presence of water-vapour in the lower atmosphere it would be a simple matter to exterpolate the values for the actual extra terrestrial value of the solar constant. Other series of determinations have been made of the chemical intensity of radiation at both stations by means of the blackening of silver citrate paper, and of the heat intensity by a Michelson actinometer. C. P. B.

1649. *Flash Lines during Partial Eclipse.* **F. C. Dennett.** (Observatory, 35. p. 302, Aug., 1912.)—Observing at Hackney during the partial solar eclipse of April 17, 1912, with a small Thorp prism-grating solar spectroscope on a 3-in. Wray telescope, a good display of lines of the flash spectrum was seen at the time of greatest obscuration near the cusps of the crescent. C. P. B.

1650. *Solar Corona, April* 17, 1912. **J. C. Solá.** (Astronom. Nachr. No. 4597. Nature, 90. p. 29, Sept. 5, 1912. Abstract.)—A drawing shows the corona extending about 2·5 solar diameters on either side of the moon's limb, the observations being made at Barco de Valdeorras, Galicia. The corona is of the minimum type. C. P. B.

1651. *Solar Eclipse Photometry, April* 17, 1911. **L. Ancel.** (Comptes Rendus, 155. pp. 267–269, July 22, 1912.)—The varying illumination was determined by means of a selenium photometer with photographic registration, installed at St. Germain-en-Laye, near Paris. The curve obtained is reproduced, showing very clearly the variations recorded during the progress of the eclipse. **H. Amann.** (Ibid. pp. 264–267, July 22, 1912.)—Observations of the eclipse (magnitude 0·868) were made at the Aosta Observatory, Italy, under somewhat unfavourable conditions owing to cloudy sky. The work comprised determination of the contact times, spectroscopic photography and photometry, and meteorology. C. P. B.

1652. *Position of Sun's Axis.* **F. W. Dyson** and **E. W. Maunder.** (Roy. Astronom. Soc., M.N. 72. pp. 564–582, May, 1912.)—The Greenwich publications of sun-spot measurements give ledgers containing the details of about 7000 separate spot groups since 1874. Equations have been formed for each group with terms involving the inclination of equator and longitude of node, and combinations of these made year by year to determine the small displacements from which the position of the sun's axis is determined. The resulting values are—

$$\text{Inclination of sun's equator to ecliptic} = 7^\circ\ 10{\cdot}6'$$
$$\text{Longitude of ascending node} = 73^\circ\ 53{\cdot}6'\ (1850).$$

The investigation is to be extended by taking the material in various sections. C. P. B.

1653. *Spectrum of P Cygni.* **E. B. Frost.** (Astrophys. Journ. 35. pp. 286–293, May, 1912.)—From a series of spectrograms of the spectrum of this most interesting bright-line star taken at the Yerkes Observatory during the period May 21, 1904, to Sept. 27, 1909, it is shown that (1) the spectrum has not varied appreciably in recent years; (2) the displacements of the dark lines are spurious, being due merely to the fact that all but the edges of the dark lines are obscured on the photographic plate by the intense bright lines; (3) the radial velocity of the dark-line system is about —82 km. per sec., and that of the bright-line system about —12 km. per sec. The velocity of the dark-line system, after correction for the solar motion, is about —65 km. per sec., which is unusually large, but not exceptional for a steady radial velocity of a helium star. The spectrum shows lines of hydrogen, helium, oxygen, nitrogen, calcium, silicon, and certain lines of elements not yet identified terrestrially. Although the spectrum in general strongly resembles that of other Novæ at certain stages of their development, there are numerous differences in details; the bright lines are narrower than in Novæ, and are only slightly displaced; the bright band at λ4640 in Novæ is not conspicuous in P Cygni; the dark lines are single; there are but few enhanced metallic lines. The evidence for believing that the displacements of the absorption lines are spurious and merely due to the concealment of the greater part of their width by the overlapping bright lines is clearly shown by means of tables giving very different values of the velocity of approach for different lines and different elements. On the contrary, the displacements of the centres of the bright lines are in good accordance, with a mean velocity of approach of 10 km. per sec. The silicon dark lines give a fairly consistent velocity during the 8 years of observation of —82 km. per sec. Taking this as evidence of the true velocity of the absorbing material, calculations are made of the probable width of the dark lines, parts of which are covered by the bright lines. Evidence of the stability of the spectrum is afforded by the observations made by Bélopolsky in 1899. Only one of the spectrograms (dated Sept. 27, 1909) was strong enough in the violet to show the K line of calcium. It appears to have no bright component, being a quite narrow dark line, yielding a velocity of 0 km., a feature quite common in spectra of B type. The similarity of certain details between P Cygni and B Lyræ is pointed out. C. P. B.

1654. *Formation of Lunar Craters.* **J. Escard.** (Comptes Rendus, 155. pp. 338–340, July 29, 1912.)—Experiments are described to illustrate possible methods of formation of certain lunar features. By melting various substances, such as bitumen or resin to form semi-fluid or pasty masses, and introducing a small quantity of water, the surface of the material is thrown up into swellings by the imprisoned water-vapour. As soon as the pressure is released by the fracture of a weak portion, generally near the top of the "*bourrelet*," the thin dome partly falls back on itself, and under certain limits of temperature, fluidity, &c., the mass solidifies sufficiently quickly to keep in shape. A photograph is reproduced showing a number of these formations, which are very similar to actual lunar features. [See Abstracts Nos. 798 and 800 (1912).]

C. P. B.

1655. *Selective Light Absorption of Moon's Surface.* **R. W. Wood.** (Astrophys. Journ. 36. pp. 75–84, July, 1912.)—In a previous paper [Abstract No. 520 (1910)] the author showed that by photographing the moon's surface with light of the shortest wave-length which is capable of traversing the earth's atmosphere, certain features are rendered prominent which cannot be seen or photographed with visible light. The progress of the investigation has been in the direction of combining these selective photographs to form material for a study of lunar petrography. These have been made with a 16-in. glass mirror, 26-ft. focus, coated with nickel, and mounted for guiding on the 23-in. refractor at Princeton Observatory. An image in yellow light was taken on a Cramer Iso plate and deep-yellow screen; a short exposure without screen gives the violet image, and an image taken through a silver film gives the ultra-violet radiation. For comparison several rock specimens and sulphur deposits were photographed through the screens, and from the results it is considered probable that sulphur may be the cause of the specially dark markings with ultra-violet transmission. [See also Abstract No. 787 (1911).] C. P. B.

1656. *Markings on Jupiter.* **T. E. R. Phillips.** (Astronom. Nachr. Observatory, 35. p. 312, Aug., 1912.)—Observations at Ashstead, Surrey, show that the Red Spot has continued to drift rapidly in longitude. In June, 1911, it was in longitude 325°, whereas in April, 1912, it was 306°. [Reference also to observations of dusky markings near Red Spot by Barnard.] **W. F. Denning.** (Observatory, 35. No. 452, pp. 319–321, Sept., 1912.)—The dusky marking seen by Barnard on May 7 has been a familiar object during the past 11 years, having been discovered by P. B. Molesworth in Feb., 1901. It has a rotation period of 9h. 55m. 19s., or about 22 sec. quicker than the Red Spot, which it overtook on May 2, 1902. Its dark material drifted to the south, flowed along the border of the Red Spot, and then northwards over the bright tropical zone of the planet. This was repeated at subsequent conjunctions in 1904, 1906, 1908, 1910. Extraordinary variations have also occurred in the length of the South Tropical Spot, which appears to exercise some influence on the Red Spot. C. P. B.

1657. *Orbit of Eighth Satellite of Jupiter.* **J. Trousset.** (Comptes Rendus, 154. pp. 1778–1779, June 24, 1912.)—An analysis is made of the principal inequalities of the movement of the satellite by the method used by Andoyer for the moon. One notable conclusion is the feeble motion of perijove, which makes a revolution round the orbit in 800 revolutions of the satellite. The node, on the contrary, has a rapid movement, its revolution being effected in 40 revolutions of the satellite. C. P. B.

1658. *Diameter of Neptune.* **G. Abetti.** (Mem. della Soc. degli Spettroscopisti Italiani, 1. No. 8. Nature, 90. p. 29, Sept. 5, 1912. Abstract.)—From a discussion of observations of the diameter of Neptune made by various workers since 1846, a mean diameter of about 69" is deduced, corresponding to a true diameter of 50,000 km. C. P. B.

1659. *Spectrum of Brooks's Comet* (1911*c*). **A. de la Baume Pluvinel and F. Baldet.** (L'Astronomie, Sept., 1912. Nature, 90. p. 29, Sept. 5, 1912. Abstract.)—Spectrograms obtained at Juvisy are reproduced, showing very clearly the changes as the comet approached the sun. Certain unknown radiations peculiar to the head of the comet decreased perceptibly between Aug. and Oct. As they became fainter the tail radiations became stronger. C. P. B.

1660. *The Light Phenomena in the Atmosphere, May,* 1910. **D. Stenquist.** (Ark. för Mat., Astron. och Fysik, Stockholm, 7. 36. pp. 1–14, 1912.)—The paper gives a summary of the optical phenomena observed during and after the transit of Halley's comet on May 19, 1910. In many places strange clouds like cirri, intense twilight phenomena, aurora borealis, Bishop's rings, halos, &c., were recorded on that day, or within a short time of it. The author concludes that the earth was then enveloped by quantities of cosmic dust, probably loaded with negative electricity, and that when the charge on the earth had reached its limit a discharge occurred which caused zodiacal light. [See Abstract No. 917 (1911).] H. F. H.

1661. *Photographic Observations of Comet* 1911*c* (*Brooks*). **E. E. Barnard.** (Astrophys. Journ. 36. pp. 1–18, July, 1912.)—The paper gives a detailed history of the comet discovered by W. R. Brooks on July 20, 1911, chiefly derived from photographs obtained at the Yerkes Observatory. Several of the photographs are reproduced to illustrate the remarkable changes undergone by the head envelopes and tail from night to night. The greater part of the delicate detail shown on the photographs was invisible to the eye in any of the telescopes used on it. Micrometric measures of the position of the comet were also made and will be communicated later. C. P. B.

1662. *Spectrum of Nova Geminorum* (1912). **T. E. Espin.** (Roy. Astronom. Soc., M.N. 72. pp. 708–709, June, 1912.)—Estimates of magnitude from March 14 to May 18, 1912, and a summary of the spectrum charges from night to night. **L. Becker.** (Ibid. pp. 709–714, June, 1912.)—Observations of the spectrum of the Nova were made with the spectrograph attached to the 20-in. reflector at the Glasgow Observatory. The wave-lengths of the lines shown are tabulated with their corresponding intensities, as photographed on March 15, 1912. **H. E. Lau.** (Astronom. Nachr. No. 4598. Nature, 90. p. 60, Sept. 12, 1912. Abstract.)—From observations made between March 14 and May 18 secondary maxima were found on March 14, 28, 31, April 18, May 1. The brightness became fairly steady about the end of May, its value being about 8·0. Observations made at Cambridge on Aug. 13 by Stratton and Brunt showed that the nebula line 501 was the strongest line in the visible spectrum. Other lines were seen at λλ464, 486, 496, 531, 575. **Giebeler.** (Astronom. Nachr. 4582. Abstract by F. W. Henkel in Observatory, 35. pp. 273–276, July, 1912.)—Deals with the identification of certain of the lines in the spectrum of the Nova with the lines of radium and its emanation. Coincidences were noted with certain titanium lines, but these were discarded owing to the absence of many of the stronger lines of that element. A table is given showing the comparison of radium and Nova lines. Küstner adds a note agreeing with the conclusions of Giebeler and Kayser, who also examined the spectra. **R. Furuhjelm.** (Astronom. Nachr. No. 4592. Nature, 89. p. 589, Aug. 8, 1912. Abstract.)—Discussion of spectra taken with the one-prism spectrograph and 80-cm. refractor at Potsdam. Coincidences are indicated between the fine dark lines of the Nova spectrum and the spark lines of Ti, Se, Sr, &c. A comparison is also made with Dyson's chromospheric lines, showing numerous identifications. **Ludendorff.** (Astronom. Nachr. No. 4592. Nature, 89. p. 589, Aug. 8, 1912. Abstract.)—Observations on a negative taken at Potsdam on March 15, 1912, show that 37 dark Nova lines between λ4310 and λ4530 coincide with lines in Rowland's table of Fraunhofer lines within certain limits depending on the velocity. Comparisons are made with the lines of radium, emanation, and uranium. Uranium gave no result, and the others were uncertain. C. P. B.

1663. *Radium in Solar Chromosphere.* **F. W. Dyson.** (Astronom. Nachr. No. 4589. Observatory, 35. pp. 297–298, Aug., 1912.)—In consequence of suggestions by Giebeler, Küstner, and Kayser [see preceding Abstract] that certain lines of the spectra of radium and radium emanation were represented in the spectrum of Nova Geminorum (1912), it was decided to examine the chromospheric spectrum for possible coincidences with these lines. A table is given showing the principal lines in the spark spectrum of radium (Runge and Precht), with chromospheric wave-lengths obtained during solar eclipses of 1898, 1900, 1901, 1905. There is a general agreement with the radium spectrum as regards intensities, and also with regard to the wave-lengths, the author's conclusion being that these lines in the chromosphere may reasonably be attributed wholly or in part to radium. A comparison has been made with the spectrum of radium emanation (Royds), but this does not lead to any decisive conclusion. C. P. B.

1664. *Orbital Elements of Eclipsing Variable Stars.* **H. N. Russell.** (Astrophys. Journ. 35. pp. 315–340, June, and 36. pp. 54–74, July, 1912.)—In the general case of eclipsing variable stars the number of quantities to be determined is 13, of which 11 have to be determined from the photometric measures. Of these the period is invariably known with a degree of accuracy greatly surpassing that for any of the other elements; the epoch of principal minimum can also be well determined by inspection of the light-curve. The problem is thus analytically studied as of two spherical stars, appearing as uniformly illuminated discs, revolving about their common centre of gravity in circular orbits and eclipsing each other. The aim is to find the relative dimensions and brightness of the two stars and the inclination of the orbit from the observed light-curve. C. P. B.

1665. *Determination of the Parallax of Stars Stereoscopically.* **S. K. Kostinskij.** (Acad. Sci. St. Pétersbourg, Bull. 11. pp. 737–745, June 15, 1912.)—Two plates are insufficient for the complete separation of the parallax of a star from its proper motion by the stereoscopic method; at least three, taken at half-yearly intervals, are required. The author considers the ideal case of three plates of the same region containing the star under investigation in the centre and taken under identical conditions. The results of determinations of the parallax of 61 Cygni in this way confirm the applicability of the stereoscopic method to the exact determination of stellar parallax. This method undoubtedly requires further development. T. H. P.

1666. *Masses of Double Stars.* **Doberck.** (Astronom. Nachr. No. 4583. Nature, 89. p. 511, July 18, 1912. Abstract.)—A series of computed masses of double stars are given with the corresponding Harvard spectral type. The average mass appears to be similar to that of the solar system. C. P. B.

1667. *Stellar Photometry.* **E. C. Pickering.** (Harvard College Observatory Circular, No. 170. Nature, 89. p. 486, July 11, 1912. Abstract.)—The adopted magnitudes of 96 stars measured in the Harvard polar sequences are given for reference. The scale reaches down to the 21st magnitude. A photograph is reproduced showing the stars near the North Pole as taken with the 60-in. reflector at Mount Wilson. C. P. B.

1668. *Micrometrical Measures and Focal Peculiarities of Nova Lacertæ.* **E. E. Barnard.** (Roy. Astronom. Soc., M.N. 72. pp. 659–676, June, 1912.)—Detailed micrometer measures are given showing the position of the Nova with respect to numerous comparison stars, and a table of magnitudes showing the decline during 1911. The star had two distinct foci, one giving a more or less colourless image at the regular focus of the telescope, the other presenting a sharp crimson image outside the main focus. This second image disappeared about the end of Feb., 1911. By May 1, or earlier, the star had changed to the nebular stage, and the focus was found to be longer than for an ordinary star. A series of notes of the varying physical appearances of the Nova image in the 40-in. telescope are added, and also a set of focal measures of well-known peculiar stars. A note is added giving focal measures for Nova Geminorum (1912), showing the same feature of a longer focus for the crimson image. C. P. B.

1669. *Dynamical Theory of Globular Clusters.* **T. J. J. See.** (Amer. Philosoph. Soc., Proc. 51. pp. 118–166, April–June, 1912.)—Analytical investigation of the mutual interaction of a mass of bodies to the number of about 1000 shows that the clustering power operates to exhaust the mutual potential energy of the system, and bring about increasing accumulation in the centre, so that the cluster finally unites into a single mass of enormous magnitude. All cosmical systems will finally end by the absorption of the attendant bodies in the central masses which now govern their motions. The density of the clusters is greater on the outer border than in a globe of monatomic gas, showing that stars are still collecting material from the surrounding regions of space. The theory affirms the growth by accretion as contrasting with the old idea of masses thrown off from a central rotating plastic molten mass. C. P. B.

1670. *Orbit of ξ Persei.* **[Miss] Cannon.** (R.A.S. Journal, Canada, Vol. 6. No. 8. Nature, 90. p. 60, Sept. 12, 1912. Abstract.)—Using the H and K lines only for measurements on plates taken at Ottawa and Yerkes, the period is found to be 6·951 days, range of velocity 15·7 km., and velocity of system 15·4 km. C. P. B.

1671. *Spiral Nebulæ Photographed in Polarised Light.* **J. H. Reynolds.** (Roy. Astronom. Soc., M.N. 72. pp. 553–555, May, 1912.)—Photographs were taken of the nebula M64, in Coma Berenices, using a 28-in. reflector and double-image prism. The two images show differences which are explainable by assuming that polarisation is present in the sense that some of the emitted light is reflected by outlying matter from the nucleus of the nebula. Further tests are to be made on the Andromeda nebula. A note added to the paper describes the differences which should be present owing to the different angles of reflection by parts of the nebula inclined to the sight line, with examples of nebulæ which show this feature. C. P. B.

1672. *Mechanism of Spiral Nebulæ.* **E. Belot.** (Comptes Rendus, 154. pp. 1780–1782, June 24, 1912.)—Experiments are described showing the formations assumed by a set of cork discs, floating on water, when brought under the influence of a central rotating disc, and the differences introduced by a superimposed translatory movement of the water. The paths taken by the objects are plotted, and are similar in general character to the curved branches of spiral nebulæ. C. P. B.

1673. *Solar Halo.* **A. Wigand** and **F. Schwab.** (Phys. Zeitschr. 13. pp. 677–684, July 15, 1912.)—Measurements of diam. of solar halo made from balloon observations near Bitterfeld on Nov. 12, 1911. A detailed table of the records is given, and a plate showing four photographs of the halo. C. P. B.

1674. *Pressure at the Sun's Surface.* **Gouy.** (Comptes Rendus, 155. pp. 115–118, July 8, 1912.)—Comparisons of the character of the lines in spectra of the solar atmosphere and of terrestrial gases and vapours suggests that the solar vapours are highly rarefied, and the various phenomena of stratification according to atomic weight appear to be in accord with this view. C. P. B.

1675. *Period and Orbit of α Persei.* **A. Hnatek.** (Astronom. Nachr. No. 4599. Nature, 90. p. 93, Sept. 19, 1912. Abstract.)—The elements are derived from radial-velocity spectrograms taken at Potsdam during the interval 1900–1908. The variability appears to be established, with period of 4·0988 days. C. P. B.

LIGHT.

1676. *New Stereoscopic Microscope with a Single Objective.* **A. Quidor.** (Comptes Rendus, 155. pp. 68–70, July 1, 1912.)—The new instrument, constructed by the Maison Nachet, is stated to show objects in striking relief with a magnification of 10 to 100 diams., while ordinary binocular microscopes with two objectives do not magnify more than 80 diams. It has the advantage of permitting the use of objectives of very short frontal distance, and hence high power, or of ordinary microscope objectives. Behind the objective are placed two prisms side by side, so that the right-hand half of the pencil of rays emerging from the objective passes through one prism on its way to the right eye, and the left-hand half of the pencil passes through the other prism on its way to the left eye. The impression of relief is produced by the fusion of the two images of the object so formed. The distance between the oculars can be adjusted to the width between the observer's eyes by rotating the prisms. The makers claim that, by the use of special oculars, any necessity for fatiguing converging effort on the observer's part is done away with.

A. E.

1677. *Torque produced by Light in Oblique Refraction.* **G. Barlow.** (Roy. Soc., Proc. Ser. A. 87. pp. 1–16, July 26, 1912.)—In 1905 J. H. Poynting developed the idea that a beam of light must be regarded as containing a stream of momentum, and showed that this principle may be used to solve with great ease the various cases in which a beam of light is absorbed, reflected, or refracted at a surface. When a beam falls normally on a perfectly absorbing surface the force exerted is the momentum received per sec., and is therefore equal to the momentum in a length V of the beam, where V is the speed of light. But the pressure exerted is equal to the energy density E of the beam. It follows then that the density of momentum in the beam must be E/V. In the present case a 1-cm. cube of glass was used with its four vertical faces optically worked. The beam of light was incident on one half of one vertical face and emerged at the other half of the opposite face. On Poynting's analysis of this case there will be an *outward* pull on the glass where the refraction occurs. These two pulls at incidence and emergence constitute the torque under examination. The cube of glass served as its own mirror to indicate the deflection occurring in consequence of the torque. Also its symmetry proved useful in simplifying the task of eliminating radiometer effects; for example, each of the four vertical faces could receive the beam in turn. The source of light was a 55-volt Ediswan focus lamp fed from accumulators. The voltage was maintained at 60 volts to within 1/10 volt, the lamp then taking 5·4 amps. In six series of experiments the deflections were respectively:—

Observed, 4·44, 4·28, 3·8, 5·7, 5·56, 5·33.
Calculated, 4·32, 4·25, 3·5, 5·46, 5·46, 5·23.

It is thus concluded that the oblique passage of a beam of light through a plate of refracting material produces on the matter of the plate a torque which has the magnitude deduced from the transfer of momentum in the beam.

E. H. B.

1678. *Absorption of Light in Space.* **F. G. Brown.** (Roy. Astronom. Soc., M.N. 72. pp. 718–728, June, 1912.)—In a former paper [Abstract No. 809 (1912)] a method was advanced for determining the absorption of light in space by comparing the brightness of large and small nebulæ. An attempt has now been made to compensate for any systematic errors of the N.G.C. by comparisons with photometric measures of certain selected nebulæ published in Harvard Annals, 37. No. 7. A suggestion is made for the hypothetical distribution of the absorbing material. C. P. B.

1679. *Quantitative Study of the Absorption of Ultra-violet Rays by Compounds of the Fatty Series.* **J. Bielecki** and **V. Henri.** (Comptes Rendus, 155. pp. 456–458, Aug. 19, 1912.)—Quantitative measurements were made of the absorption of ultra-violet light of 12 wave-lengths from λ2144 to 3000 by organic compounds of the fatty series. These showed (1) that the alcohols give a continuous absorption, increasing regularly from λ3000 to 2144, the absorption increasing very rapidly in the homologous series, *e.g.* in the ratio 1 : 2·5 : 7·5 : 50 for CH_4O, C_2H_6O, C_3H_8O, and $C_4H_{10}O$. (2) The absorption by monobasic acids is about 2000 times stronger than by methyl alcohol; it is almost equal for formic and acetic acids, a little less for propionic, and a little more for butyric acid. (3) Of the dibasic acids, oxalic acid produces an absorption 15 times greater than the monobasic acids or 30,000 times greater than methyl alcohol. But the homologues, in which the carboxyls are separated by one or more methylene groups are only 1½ times more absorptive than the monobasic acids. (4) The esters are less absorptive than the acids. (5) Formaldehyde is about 12 times more absorptive than methyl alcohol. The three homologues show a band at about λ2800, and become more absorptive as the molecular weight increases. (6) Three ketones showed a band in a similar position at λ2680. But the absorption for shorter wave-lengths diminished progressively without reaching the minimum shown by the aldehydes. T. M. L.

1680. *Mixtures of Amorphous Sulphur and Selenium as Immersion Media for the Determination of High Refractive Indices with the Microscope.* **H. E. Merwin** and **E. S. Larsen.** (Amer. Journ. Sci. 34. pp. 42–47, July, 1912.)—The difficulty of identifying transparent minerals, &c., the refractive indices of which cannot at present be determined under the microscope because of the lack of suitable immersion media, has led to the experiments discussed. In a molten condition sulphur and selenium are miscible in all proportions. The mixtures can be melted readily on a glass slip held over a low flame, and when melted, readily adhere to pulverised minerals. The cooled mixtures rich in Se remain amorphous for months, those very rich in S may crystallise almost instantly. With increasing Se the refractive indices of the mixtures increase from about 1·98 to 2·92 for Na light, and from 1·96 to 2·72 for Li light. Curves for certain wave-lengths are given, showing the variation of refractive index with proportion of Se in such a mixture. Having given the indices of the mixtures, it only remains to match the index of the substance under investigation with the index of a mixture by one of the well-known microscopic methods. Mixtures containing more than 45 % of Se are red, and their indices must be expressed in wave-lengths of red light. The preparation may be observed through a thin film of Se pressed out under a cover-glass on a glass slide, and used as a screen over the eyepiece of the microscope. Such a film transmits light almost equivalent to Li light, and may be used with any of the mixtures for determining approximate indices for Li light. The material under examination should be finely powdered so that the mixture may be pressed out into a thin film. If it is desired to obtain indices with errors as small as 0·005, it is essential to use monochromatic light or suitable screens, owing to the high dispersion of Se. For Se the two Na lines have a difference of refraction of 0·004, and the Na flame cannot be used with mixtures containing more than about 70 % Se. Lithium light can be used with all the mixtures. A spectroscope monochromatic illuminator may be used to advantage, particularly as a time-saver. With it the necessity for making up a mixture which exactly matches the index of the substance studied for a particular wave-length is avoided. An approximate match may be made in white light, then with the same mixture the wave-length at which the refractive indices are alike can be found by means of the illuminator. Another mixture can then be selected matching the index for a very different wave-length. The index for one of the common standard wave-lengths can then be obtained by interpolation. The mixtures are prepared by weighing into a 3-in. test-tube the required amount of Se, heating till the Se is thoroughly fused, allowing to cool, adding the S and heating over a low flame just sufficiently hot to allow thorough mixing with a glass rod. As the material cools it may be gathered on the rod, removed, cut into fragments, and kept in a stoppered tube. One or two gm. is enough for examining 100 preparations. For use with the microscope, a little mixture and mineral powder are heated on a glass slip under a cover-glass till the mixture is fluid, then mixed and pressed into a thin film, heated again till bubbles appear, and again pressed. Artificially crystallised S should be used. The index of a mixture, correct to 0·001, may be found on the goniometer by melting the mixture in the angle between two strips of glass. If this index is to equal that of the film containing the mineral, the mixture must be heated to 250° or more before being put in the prism. Mixtures containing less than 15 % Se crystallise too rapidly for accurate work. Certain liquids with indices from 1·8 to 2·1 will be considered in a later paper. A. E.

1681. *Spectro-photometry.* **E. P. Hyde.** (Astrophys. Journ. 35. pp. 237–267, May, 1912.)—The paper is in two portions, one dealing with the corrections involved in spectro-photometric operations by the use of slits of finite width, and the other describing a new pattern of sector disc adapted for delicate variation. The main feature of the latter is the utilisation of sector openings whose edges are not radial from the axis of rotation. [See Abstract No. 811 (1900).] C. P. B.

1682. *Optical Experiments.* **H. S. Ryland.** (Nature, 89. pp. 554–555, Aug. 1, 1912.)—*Exp.* 1.—A white cardboard disc of 36 in. diam., inscribed with a series of black rings ¼ in. wide and 1 in. apart, is hung on the wall of a room fitted with a central cluster of three electric lights of 100, 50, and 8 c.p. With all the lights on, the central white disc is steadily regarded from a distance of 3 ft. for 15 secs. If the 100-c.p. lamp be then switched off, the whole disc will for a moment vanish; then the central white spot only will reappear. After about 10 secs. the outer white ring will reappear, followed by the others in succession towards the centre. *Exp.* 2.—In this case the 50-c.p. lamp is not used, and when the 100-c.p. lamp is switched off, the outer rings appear first and the central disc last. *Exp.* 3.—A piece of black velvet about 9 in. square is fastened on a piece of very dark grey paper or board about 36 in. square, and the light reduced till the velvet is barely visible. After gazing at the velvet for about 4 secs. the outer edges of the paper will appear to darken, and by degrees paper and velvet will become enveloped in absolute blackness. The author remarks that these three experiments indicate that the retina depends for its action upon sensitisation from the periphery inwards; also that this sensitisation is dependent upon light falling on the periphery. *Exp.* 4.—An oculist's ordinary test-type is hung on the wall of the same room, and the letter T in the 6/18 line regarded steadily from a distance of 12 in. After a few secs. the white paper around the letter appears to grow brighter. If the 100-c.p. lamp be now switched off, the brightness will increase and assume a bluish tinge until "the letter appears to float in a Bunsen flame." The author would be glad if others would confirm the experiments. A. E.

1683. *Contrast Colours in the Use of Zone-plates.* **W. B. Croft.** (Nature, 89. p. 581, Aug. 8, 1912.)—A zone-plate is placed at 14 ft. from an electric glow-lamp; 6 ft. further on a red image of the filament is formed, which is conveniently observed with a microscope eyepiece. As this is moved away from the plate, there follows in view a continuous succession of images in all the colours of the spectrum. The chromatic dispersion extends along the general axial line through more than 6 ft. Whatever may be the colour of the filament, the groundwork of the circle of illumination assumes the complementary colour. It is surprising to observe how strong is the yellow field impressed upon the eye, while the violet image is growing imperceptible. A. E.

1684. *New Treatment of Optical Aberrations.* **R. A. Sampson.** (Roy. Soc., Phil. Trans. 212. pp. 149–185, July 27, 1912.)—It is shown how the method developed by Gauss, hitherto limited to systems in which the relations of original and emergent rays are strictly linear, may be extended and retained throughout the discussion of the aberrations of any coaxial system. A discussion is given of the general relationships of the well-known Petzval condition and the Abbe sine condition, and furnishes a ready method of describing, analysing, and measuring the faults of an optical image, being particularly adapted to numerical calculations. C. P. B.

1685. *Monochromator for the Ultra-violet Region.* **C. Leiss.** (Zeitschr. Instrumentenk. 32. pp. 292–294, Sept., 1912.)—This apparatus, also made by R. Fuess, of Berlin-Steglitz, is externally very similar to the one already dealt with for the visible region [see Abstract No. 840 (1909)]. The micrometer drum reads directly in wave-lengths, and is divided for the range 500–200 $\mu\mu$. L. H. W.

1686. *Electron Theory of Dispersion and Absorption of Metals.* **D. Enskog.** (Ann. d. Physik, 38. 4. pp. 731–763, July 12, 1912.)—A mathematical theory which deduces optical constants of the right order of magnitude, but does not succeed so well with the electrical constants. E. H. B.

1687. *Spectrum of Molybdenum.* **C. Weigand.** (Zeitschr. wiss. Phot. 11. pp. 261–276, Aug., 1912.)—Gives accurate wave-length tables of the arc and spark lines of the element from $\lambda = 4647$ to $\lambda = 7184$. A Rowland concave grating was used. A. W.

1688. *Absorption of Light in Andalusite.* **M. Lewitskaja.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 504–512, 1912.)—

Describes experiments on a crystal of andalusite from which absorption curves were obtained for the visible spectrum for directions parallel to the three axes of symmetry. The results are tabulated and graphed. A. W.

1689. *Photochemical Equivalent Law.* **A. Einstein.** (Ann. d. Physik, 38. 4. pp. 881–884, July 12, 1912.)—Supplementary to the author's previous note [see Abstract No. 1046 (1912)].

1690. *Diffraction of Waves of Positive and Negative Amplitude.* **W. Rybczyński.** (Phys. Zeitschr. 13. pp. 708–710, Aug. 1, 1912.)—The author has investigated theoretically the effects of diffraction with a partially periodic radiation and compares the results with those obtained with a homogeneous radiation and with a totally non-periodic radiation. E. M.

1691. *Detection of Small Amounts of Polarisation in Light from a Dull Sky.* **A. E. Oxley.** (Cambridge Phil. Soc., Proc. 16. pp. 561–570, July 24, 1912.)—The fringes produced by plane-polarised light from a bright sky when the light passes through a Babinet's compensator disappear when dark clouds intervene. But the author finds that if a polarising rhomb be placed in front of the compensator (between sky and compensator), then for certain positions of rhomb and compensator and analysing nicol the bands again become visible. The rhomb used is a bi-trapezoid which produces a relative phase-difference of $\pi/2$ over a wide range of wave-length, and admits of accurate adjustment with respect to the principal direction of the analysing nicol. Moreover, a rhomb of this form can be rotated without displacing the beam laterally. On placing a Nicol prism in front of the rhomb the visibility of the bands is increased. The existence of a small amount of polarisation in light from a dull sky can be detected by the method when no trace of it can be obtained by means of the tints produced in crystalline plates. The direction of the mean plane of polarisation can also be ascertained. After passing through the polarising rhomb and compensator, the plane-polarised vibrations in the incident light give rise to bands in the field of view of the compensator, which are like the Babinet bands when the sky is bright, but are slightly broader and fainter when the sky is dull. When the sky is dull, plane-polarised vibrations of widely different azimuths, reflected from neighbouring parts of the sky, are of importance, and these give rise to the slight attenuation of the bands. A mathematical explanation of the effects is given. It is suggested that the arrangement might be used as a direct-reading polarisation chronometer, which would not require setting each time the hour was required. A. E.

1692. *Chemical Reactivity and Absorption Spectra.* I. **E. C. C. Baly** and **F. O. Rice.** (Chem. Soc., Journ. 101. pp. 1475–1482, July, 1912.)—The authors consider that chemical changes depend on the opening-up of closed systems of lines of force within the molecules. Thus water enables ammonia and hydrogen chloride to interact because the force due to its residual affinity penetrates the closed systems of force of the ammonia and hydrogen-chloride molecules, which (according to the authors' theory) must presumably possess no residual affinity. This opening of the lines of force is also regarded as the source of fluorescent spectra. A number of absorption spectra are plotted in which the first effect of sulphuric acid on (*e.g.*) nitroanisole is to shift the absorption band into the visible region of the spectrum : sulphonation then takes place, and the band returns to the ultra-violet. In certain cases the position of the displaced band agrees with that of the fluorescent spectrum of the substance. T. M. L.

1693. *Pole Lines in Arc Spectrum.* **R. Rossi.** (Astrophys. Journ. 35. pp. 279–285, May, 1912.)—When the image of an electric arc is projected on the slit of a spectroscope, there are generally a special set of short lines due to the tips of the electrodes. [Abstracts Nos. 1104, 1620 (1908).] These are generally stronger and more numerous in the ultra-violet region of the spectrum, and are often sharply defined when the lines from the middle portions of the arc are broad or nebulous. To test if these polar lines are due to potential gradient, photographs of the spectrum of an iron arc fed by currents of 2·5–18 amps. were taken with a 21½-ft. concave grating spectrograph. In these the polar lines were stronger at the positive pole with large currents, and of equal intensity at the two poles for small currents, and the general conclusion is that temperature, or eventually potential gradient, may be the cause of production of the lines. C. P. B.

1694. *Pressure Displacement of Spectral Lines.* **T. H. Havelock.** (Astrophys. Journ. 35. pp. 304–314, June, 1912.)—A comparison is suggested between observed pressure effects in emission spectra and a displacement of absorption lines which can be deduced theoretically from a certain type of dispersion formula. Certain theories of the pressure effect are discussed, and it is concluded that they all lead to a displacement which is many times too small; these theories ascribe the effect to the magnetic influence of neighbouring atoms of the metallic vapour or of the surrounding gas, or to the dielectric influence of the surrounding gas. It is suggested that an effect of the right order may be obtained from the electric influence of neighbouring similar atoms of the metallic vapour. C. P. B.

1695. *Pressure-shift of Spectral Lines.* **W. J. Humphreys.** (Astrophys. Journ. 35. pp. 268–272, May, 1912.)—Sanford has recently shown [Abstract No. 495 (1912)] that there appears to be a considerable amount of evidence that the pressure-shift of spectral lines is related to those properties of the atom which seem to depend upon the specific inductive capacity. Humphreys has previously pointed out that the pressure-shift shows a relation to the atomic weight, which would involve the above conclusion also, and in fact, all the properties of the atom which are periodic functions of the atomic weight. One of the chief difficulties in the acceptance of this theory is that it does not account for the spreading of the line to the violet which is so often a feature. The three theories which have been advanced (forced vibration, specific induction, and magnetic) are then discussed in some detail. C. P. B.

1696. *Ultimate Lines in Spectra of Oxyhydrogen Flame and Spark.* **W. N. Hartley** and **H. W. Moss.** (Roy. Soc., Proc. Ser. A. 87. pp. 38–48, July 26, 1912.)—The ultimate lines of a number of elements have been investigated by de Gramont [Abstract No. 1344 (1907)], who found that the ultimate rays are generally the same for spectra taken from the condensed spark, with or without self-inductance, for the spark without condenser, for the arc, and for flames at high temperatures when the reaction is a very sensitive one. There are, however, so many important exceptions that it is necessary to ascertain the ultimate lines of the same elements when the spectra are produced in different ways. The wave-length of the ultimate line observed in any spectrum depends on whether the observations are made with the eye only, or by photography, and when by photography, it depends on the sensitiveness of the photographic plate. In the oxyhydrogen flame spectra, which seldom extend beyond $\lambda 8000$ when photographed, the ultimate lines are, as a rule, found to be in a region of less refrangibility than when, with the same element, condensed sparks are employed. The actual quantities of matter which render the ultimate lines in various spectra are of great importance, as they differ widely. The delicacy of the spectrum reaction in flames, though dependent on the volatility of a substance and the intensity of the action, chemical or physical, of the emitted rays and the sensitiveness of the photographic plate, is not increased in proportion to the increase of temperature in the flame. Thus, though the temperature of the acetylene and oxygen blow-pipe flame is higher than that of the oxyhydrogen flame, yet the efficiency of the latter is greater than that of the former, by reason of the greater facility with which it effects the chemical reduction of oxides and oxy-salts. A table is given of the ultimate lines in the oxyhydrogen flame spectra of the following solid substances volatilised in the flame, with the quantities of the elements which give the lines: Li, K, Rb, Cs, Ca, Sr, Ba, Cu, Ag, Au, Ga, In, Tl, Sn, Pb, Mn, Ni. The results obtained have been applied to the quantitative analysis of minerals, also to slag and flue dust, the by-products of metallurgical operations. Similar results were obtained using dry electrodes with the condensed spark. In addition to the above metals the following were dealt with: Hg, Cd, Bi, Al, Ti, Zn, U, Ir, Pt, Fe, Co, Sb, As, C, V. [See also Abstract No. 1340 (1911).] A. W.

1697. *Study of the D Line in Absolute Units, and Application to Solar Physics.* **Gouy.** (Comptes Rendus, 154. pp. 1764–1767, June 24, 1912.)—In studying flames laden with metallic vapours, the author has found that the optical properties (emission, absorption, width of lines, &c.) depend neither solely on the density of the metallic vapour nor the thickness of flame, but on the product q of these two quantities. This conclusion appears at first sight to be in contradiction with the fact that to obtain very fine lines, and high orders of interference, with the electric arc and Geissler tubes, the vapour density must be very small. But in Geissler tubes the vapour is pure, while in the experiments it is diluted with a great excess of flame gases, which quite alters the case. For if the vapour is pure, collisions will take place between the atoms, with a frequency proportional to the vapour density. But if the flame contains, say, only one atom of metal to 10^6 molecules or atoms of flame gases, then collisions between two atoms of metal will be too rare to be worth considering. If the number of metallic atoms be multiplied by 2, 3, or 4, the same remark still holds; thus the optical properties of the mixture depend on the total number of metal atoms, and not upon the density of the metallic vapour. To measure the value of q for the D line, a few centigrammes of NaCl are slowly volatilised in an air chamber, the air in which, after sufficient lapse of time, serves to feed the flame. In measuring i, the absolute brightness of the D line, the unit adopted is the quantity of light emitted between λ and $\lambda + 1$, in the neighbourhood of the line, by a Drummond lamp regulated so as to give neither a bright line nor a dark line with the flame. Suppose a curve drawn to represent the emitting or absorbing power p as a function of λ, then the area contained between this curve and the axis of λ represents the brightness i for the whole line. A small table is given showing, for several corresponding values of q and i, the value of the ordinate of the centre of gravity of this area, and also the "reduced width" of the line, defined as the width it would have in Ångström units if the emissive power were the same throughout its extent, and the centre of gravity occupied its true place. This reduced width is constant for small values of q, then increases with q, and finally becomes much greater than the distance between D_1 and D_2, which is equal to 6 adopted units. For D_1 and D_2 considered separately, the reduced width is 0·028 for small values of q. For larger values the width is 0·42 and 0·58 times respectively the width of the D line. If the image of the crater of the electric arc be projected across the flame to fall upon the slit, the D lines will appear as absorption lines. In applying the results to the sun, the flame is supposed to have a thickness of 1000 km. (*i.e.* the thickness attributed to the solar reversing layer), and the electric arc is supposed to be replaced by a similarly radiating infinite surface, placed normally to the line of sight. On comparing the reversed lines D_1 and D_2, produced in the actual arc experiments, with the same lines in the solar spectrum, it is seen from the author's table that for the smallest values of q the laboratory lines are much fainter than the solar. As q increases the laboratory lines grow wider and more diffuse than the solar, and continue to do so till the difference is enormous, and finally D_1 and D_2 merge. The agreement is most satisfactory for values of q of order 2×10^{-10}, the inference being that a flame of 1000 km. thickness giving rays analogous to the solar rays would only contain something like 2×10^{-18} gm. per cm.^{3} or 2 mgm. per cubic kilometre. The rarity of the sodium vapour would therefore be a hundred million times higher than that of a good Crookes' vacuum.

A. E.

1698. *Series in Spectra of Tin and Antimony.* **T. van Lohuizen.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 31–45, June 25, 1912.)—The author makes use of the following fundamental idea to develop a spectral formula: For every series the curve obtained by using the parameters 1, 2, 3, &c., as abscissæ and the reciprocals of the wave-lengths as ordinates, is exactly the same, only referring to another system of axes. This curve is of the third degree: $y = -N/x^2$, where $y = 10^8/\lambda$ and N is the universal constant occurring in the formulæ of Rydberg, Ritz [Abstract No. 914 (1908)] and Mogendorff-Hicks. Transferred to one and the same system of axes, the general formula reduces, for small rotations of the axes, to—

$$10^8/\lambda = b - N/[x + a' + c/\lambda]^2,$$

which closely resembles Ritz's formula and includes as special cases the formulæ of Rydberg ($c = 0$) and of Balmer for the hydrogen series ($a' = 0$ and $c = 0$). Applying his formula to the lines of Sb and Sn, making use of the constant frequency-differences discovered by Kayser and Runge, the author finds numerous series, but is unable to separate them into principal and subordinate series in the absence of information as to the Zeeman-effect for many lines in the ultra-violet region.

A. W.

1699. *Tertiary Wave-length Standards.* **C. E. St. John and L. W. Ware.** (Astrophys. Journ. 36. pp. 14–53, July, 1912. Contribution from the Mt. Wilson Solar Observatory, No. 61.)—At a meeting of the International Union for Co-operation in Solar Research held at Mount Wilson during Aug.–Sept., 1910, the question arose as to the adaptability of the plane grating spectrograph of long focus to interpolating between the secondary standards in the determination of the standards of the third order, and in the measurement of arc, spark, and solar spectra in the newly adopted International Units. The original recommendations had been directed chiefly to the possessors of concave gratings, as in the opinion of some the abnormal spectrum given by the plane grating introduced difficulties. Several excellent high-power plane grating spectrographs are now in use, and the present paper gives detailed evidence for accepting that instrument as in every way being capable of the most accurate work in spectroscopic wave-length determination. Two series of plates of the spectrum of iron were taken with the 30-ft. plane-grating Littrow spectrographs at Mount Wilson and Pasadena, and a special reduction made to test the International Standards, the results being given in detail. One important result is that the delicacy of the measurements have resulted in the detection of the change of wave-length produced by the difference of atmospheric pressure at the two laboratories, about one-fifth of an atmosphere. It is concluded from the discussion that the precision attainable with the plane grating spectrograph in determining the absolute wave-lengths of standards of the third order by interpolation between the International Standards is 0·001 Å. in the case of good lines. Two entirely separate instruments were used, and the mean of the differences between the wave-lengths in the two series is 0·0010 Å, a quantity less than the sum of the probable errors. The secondary standards between λ5871 and λ6494, except λ5763, were examined in reference to their relative wave-lengths, and the conclusion arrived at that there are no errors exceeding 0·001 Å. except in the case of the line λ5484, which reaches 0·002 Å. Of the 100 lines studied in this region, 17 were found to be thoroughly suitable for secondary standards, and 25 for tertiary standards; 44 were discarded because of abnormal pressure displacements accompanied by dissymmetry. From the influence of pressure displacement it is evident that the behaviour of all lines to be adopted for standards should be thoroughly investigated. This is also necessary for the barium lines which are proposed to fill in the gaps where iron lines are too sparse for interpolation. In extending the series of standards to the red, special caution should be exercised in examining their behaviour with regard to pressure. C. P. B.

1700. *Argon Spectrum.* **G. Stead.** (Cambridge Phil. Soc., Proc. 16. pp. 607–609, July 24, 1912.)—The red argon spectrum is obtained from the capillary portion of an ordinary discharge tube when used with an induction coil. With a suitable capacity in circuit, or using a large coil and a narrow capillary, the blue spectrum is given by the light from the capillary portion. It is not known whether the factor which determines the production of one or the other of the two spectra is average current density, max. current density, potential gradient, or some other cause. It was hoped that by a change of one or more of the variables the red and blue spectra might be obtained at will. The discharge tube finally adopted was about 2·5 cm. in diam. and about 8 cm. long, provided with a short side tube about 1 cm. diam., into which the Al anode was sealed. Through the wider tube two stout Pt-wires were sealed, which carried a thin Pt strip forming the kathode. A battery of small storage cells was used and voltages from 100 to 2000 volts were tried. With the pressure not lower than about 0·02 mm. a definite and fairly bright positive column was produced, which always showed the red spectrum without a trace of the blue spectrum. At lower pressures the positive column practically ceased to exist. The beam from the kathode was always blue in colour and usually very bright except at low voltages. Temperature and voltage alterations produced changes, but at the anode only the red spectrum could be produced, whilst at the kathode a mixture of red and blue or pure blue alone could be obtained according to circumstances. A. W.

1701. *Continuous Spectrum of Metallic Vapours.* **Gouy.** (Comptes Rendus, 155. pp. 22–26, July 1, 1912.)—Calculation is made of the variations of density and thickness of vapour effective in producing continuous radiation, with a table for the particular values relating to sodium vapour. A short discussion is given of the application of the work to the study of the solar spectrum, with the conclusion that the parts of the sun sending out visible radiations only contain the metallic vapours in a degree of extreme rarefaction. C. P. B.

1702. *Phosphorescence of Selenium Compounds.* **W. E. Pauli.** (Ann. d. Physik, 38. 4. pp. 870–880, July 12, 1912.)—A continuation of previous work on phosphorescence [Abstract No. 1023 (1911)]; in the present paper compounds of selenium with Sr, Cu, Ca, Bi, Pb, Ba are dealt with. It is shown that it is possible to replace the sulphur atom in molecules of phosphorescent compounds by the selenium atom; the Se "phosphores" show in general the same properties as the corresponding sulphur compounds. They can, however, be distinguished from them (i) by their smaller insulating power; (ii) by a smaller number of visible bands belonging to the heavy metal occurring in the compound in question, than is the case with the sulphur compound; (iii) by an exceptionally low upper temperature limit of the glow after excitation. A. W.

1703. *Theory of Fluorescence.* **E. C. C. Baly and R. Krulla.** (Chem. Soc., Journ. 101. pp. 1469–1474, July, 1912.)—In any compound formed by virtue of the primary valencies of its atoms alone, the secondary valencies are unsaturated, so that each atom must be the centre of a field of force, the nature and strength of this field depending on the nature of the secondary valencies. Such condition is contributed to by any unsaturation which may occur with the primary valencies. The independent existence of the several fields of force in any one molecule must result in a metastable condition, since the lines of force of the different fields would necessarily condense with escape of free energy. Such closed systems may be opened by supplying to them free energy by the influence either of light or of a solvent. The opening-up process is regarded as occurring in several stages, in each of which definite light-waves are absorbed. A theory of fluorescence based on these considerations is supported by certain experimental results. T. H. P.

1704. *Negative Result on Refraction of X-rays.* **J. C. Chapman.** (Cambridge Phil. Soc., Proc. 16. pp. 574–579, July 24, 1912.)—The experiments described deal with attempts to obtain refraction effects using a prism of ethyl bromide vapour. In the first experiments the beam used was heterogeneous and such as to excite an intense characteristic radiation of the bromine. A negative result was obtained; the experimental conditions being such as would have revealed refraction to such an extent that $\mu = 1{\cdot}0003$. In the second experiments results analogous to anomalous dispersion were aimed at, a heterogeneous beam being used of that degree of hardness necessary for selective absorption by the bromine. The results were also negative. E. M.

1705. *Röntgen Radiation from Substances of Low Atomic Weight.* **C. A. Sadler and P. Mesham.** (Phil. Mag. 24. pp. 138–149, July, 1912.)—Barkla and Sadler have shown that from substances of atomic weight higher than 40, the secondary radiation is characteristic of the substance and consists in the main of one or more homogeneous beams. In the present paper substances of low atomic weight are investigated, carbon in particular. The exciting beam falling on the carbon consisted of the homogeneous secondary radiations from various substances of higher atomic weight, *e.g.* Fe, Zn, As, &c., and the absorption qualities of the radiation given out by the carbon were studied. No evidence of a homogeneous radiation from the carbon could be obtained, for the absorption coefficient varied largely according to the incident radiation, and the results could not be altogether explained on the assumption that the radiation consisted of a homogeneous radiation together with a scattered radiation. The authors conclude that a homogeneous beam when scattered by a substance of low atomic weight is transformed into a softer type of radiation. The harder the exciting beam the more profound is the change in its quality on scattering, and the greater the intensity of the scattered radiation. E. M.

1706. *Theory of Absorption and Scattering of α-Rays.* **C. G. Darwin.** (Phil. Mag. 23. pp. 901–920, June, 1912.)—The α-particles from radio-active substances have been thoroughly investigated so that the main features of their motion are now well known. On account of their great mass they go straight, or nearly straight, through matter until their energy is exhausted, the ionisation produced being proportional to the rate of loss of energy. It is thus necessary to adopt a structure for matter such that the α-particle pulls electrons out of the atoms containing them, and in so doing loses velocity. The author takes the atomic structure proposed by Rutherford [Abstract No. 1347 (1911)]. This supposes the atom to consist of a cluster of electrons held by an unknown field of forces round a central charge, which latter is of such amount as to neutralise them and which is supposed to be the seat of the mass of the atom. The author assumes that the electrons in the atom act on the α-particle with the ordinary law of inverse-square, and in considering the motion of an α-particle the effects of the perturbation of the electron by the rest of the atom are neglected. An equation is deduced relating the velocity of α-particles to the distance they have travelled from their source, and this "velocity curve" agrees closely with the experimental curve of Geiger [Abstract No. 1250 (1910)]. From the equations the number of electrons in the atom is calculated and found to be intermediate between the atomic weight and its half. The atomic radii are found to decrease with increasing atomic weight. The numbers obtained from the consideration of the absorption of α-particles are applied to scattering, and give results in all cases in good agreement with experimental measurements. E. M.

1707. *Measurements of Radio-activity by α-Rays.* **W. R. Barss.** (Amer. Journ. Sci. 33. pp. 546–550, June, 1912.)—It is well known that in a gas ionised by α-particles a saturation current is obtained only when a much larger potential gradient is applied between the plates of the ionisation chamber than is necessary when β- or X-rays are the ionising agents. This effect has been traced to the fact that the ions are produced in columns along the trajectories of the individual α-particles. Thus in ordinary electroscope measurements by α-rays saturation is not obtained, and the question arises as to whether comparative measurements can be made under these conditions. The author has investigated this question in the case of RaEm enclosed in an ionisation vessel such as is used for comparing quantities of Ra by the emanation method. Quantities of emanation of the order 10^{-8} Curies were used. The results show that even when currents are used less than 1/5 of the saturation values, the ratio of the currents from two sources of different intensities is constant for different potentials applied to the ionisation chamber. E. M.

1708. *Variation in the Velocity of β-Rays by Passage through Matter.* **O. v. Baeyer.** (Phys. Zeitschr. 13. pp. 485–489, June 1, 1912.)—In a former paper v. Baeyer, Hahn and Meitner have investigated the velocities of the β-rays emitted by the various products of the thorium family [Abstract No. 1187 (1911)]. The author has extended the results by determining the change in velocity with the thickness of material traversed and with the nature of the material. The results show that the quicker β-rays suffer a smaller deviation in velocity than slower ones in passing through the same thickness of material. An originally homogeneous pencil of β-rays becomes heterogeneous after passing through matter. For small thicknesses of material and velocities less than about 0·65 of the velocity of light Whiddington's formula $\beta_0^4 - \beta_x^4 = ax$ was found to hold, where β_0 is the initial velocity and β_x the velocity of a β-particle after passage through a thickness x. The values of the constant a were determined for Al, Sn, Cu, and Pt. For velocities greater than 0·8 of the velocity of light, there appears to be no simple relation between the velocity and the thickness of material traversed. E. M.

1709. *Nature of γ-Rays Excited by β-Rays.* **J. A. Gray.** (Roy. Soc., Proc Ser. A. 86. pp. 513–529, June 27, 1912.)—The main question considered in the present paper is whether the γ-ray excited in matter by a β-ray travels in the direction of the β-ray, this question being of considerable theoretical importance. As source of β-rays RaD(+ E) was used, this β-radiation being accompanied by only a small amount of primary γ-radiation. The experiments show that the emergent γ-radiation excited by the β-rays in plates of different materials is greater in amount and more penetrating than the incident radiation. It increases in penetrating power with increase of atomic weight of the radiator. The ratio of emergent to incident γ-radiation is shown to be greater, for radiators of the same material, the thinner the radiator, and for radiators of different materials thick enough to stop the β-rays, the lower the atomic weight. The results are shown to be quantitatively in agreement with the hypothesis that the excited γ-ray is an entity the direction of which is nearly that of the β-ray exciting it. It also follows that for β-rays of the speed used the chance of a β-ray making a γ-ray is roughly proportional to the atomic weight of the radiator, provided the β-ray spends its range in the radiator. On the view that the excited γ-ray is an entity there are two distinct theories: (1) The β-ray forms part of the γ-ray and gives it its energy and direction—Bragg's theory. (2) The β-ray supplies the energy, but does not form part of the γ-ray, which travels on as a "bundle" of energy, without change of form. Stark has put forward a theory of this kind. He considers the X- or γ-ray to be of the same nature as light, and obtains the direction of the radiation by considerations of momentum. E. M.

1710. *Mobility of RaB Ions.* **S. Ratner.** (Comptes Rendus, 155. pp. 453–455, Aug. 19, 1912.)—Franck has determined the values of the mobilities of the atoms of ThD projected from ThC and obtained values 1·48 in air and 6·32 in hydrogen, in good agreement with the values for ordinary positive ions: $K^{+}_{air} = 1{\cdot}37$; $K^{+}_{H_2} = 6{\cdot}12$. The author has investigated the mobilities of the recoil atoms of RaB projected from RaA. The method employed consists of a slight modification of Rutherford's alternating-current method. The values obtained are: 1·35 in air, and 5·65 in hydrogen, at atmospheric pressure. These values are in agreement with those for the ordinary positive ions within the experimental error. The mobilities at reduced pressure down to 10 cm. Hg were also studied, and found to be inversely proportional to the pressure. E. M.

1711. *Disintegration of Radium C.* **K. Fajans.** (Phys. Zeitschr. 13. pp. 699–705, Aug. 1, 1912.)—In a previous paper the author showed that the disintegration of RaC is irregular and that RaC_1 (19·5 min.) gives rise both to RaC_2 (1·4 min. β) and to RaD [Abstract No. 1351 (1911)]. The present experiments show that the ratio of the numbers of atoms disintegrating in the branches RaC_2 : RaD is about 3 : 10,000. The author considers the scheme by which this disintegration takes place, by analogy with that suggested by Marsden and Darwin for ThC, and arrives at the following:—

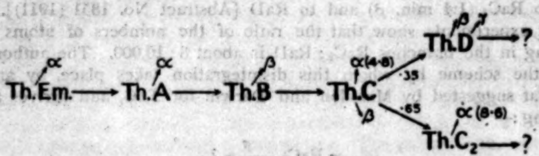
$$\begin{tikzcd}
 & & RaC_2 \arrow[r, "\beta"] & ? & & \\
RaB \arrow[r, "\beta"] & RaC_1 \arrow[ur, "(\alpha)"] \arrow[dr, "\beta"'] & & & & \\
 & & RaC' \arrow[r, "\alpha", "7{\cdot}1\text{ cm.}"'] & RaD \arrow[r] & RaE \arrow[r] & RaF.
\end{tikzcd}$$

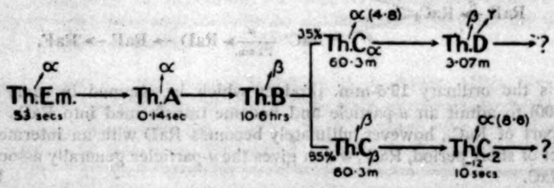
RaC_1 is the ordinary 19·5-min. product which is assumed in some cases (3/10,000) to admit an α-particle and become transformed into RaC_2. The main part of RaC_1, however, ultimately becomes RaD with an intermediate product of short period, RaC′, which gives the α-particles generally associated with RaC. E. M.

1712. *Effects of Friction in a Vacuum on Thorium Oxide.* **R. Howlett.** (Nature, 89. pp. 606–607, Aug. 15, 1912.)—Various substances were placed in vacuum tubes which were shaken on a mechanical rocker. The electrodes were connected to electroscopes and the charges generated are investigated, Anomalous effects are observed with pitchblende and ThO_2, giving the impression of a mechanically produced increase of radio-activity. E. M.

1713. *Radio-activity of Rubidium and Potassium Compounds.* **E. H. Büchner.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 22–26, June 25, 1912.)—The photographic action of several salts of Rb and K was examined and found not to depend on previous exposure to light. The author concludes that both elements are naturally radio-active, emitting β-particles. α-rays were tested for without success, both by the scintillation method and by a method in which evidence was sought as to the heating effect. E. M.

1714. *Transformation of the Active Deposit of Thorium.* **E. Marsden** and **C. G. Darwin.** (Roy. Soc., Proc. Ser. A. 87. pp. 17–29, July 26, 1912.)—A series of experiments were undertaken with a view to discovering the genetic arrangement of the various products of the active deposit of thorium, more especially the nature of the transformations which take place in the product or products generally included under the name ThC. These transformations are of unusual interest and importance, for there is undoubted evidence in this case that the atoms of a single kind of matter have two distinct modes of disintegration. By magnetic deflection of the α-particles from Th active deposit the result of Marsden and Barratt, that the α-particles of 4·8 cm. and 8·6 cm. range do not occur in equal numbers, has been confirmed [see Abstract No. 686 (1912)]. Chemical, physical, and recoil experiments, however, alike fail to separate the atoms giving the α-particles of the two different ranges. It is shown that ThC emits very penetrating β-rays ($\mu = 18{\cdot}5\ \text{cm}^{-1}$ Al) practically unaccompanied by γ-rays, while ThD gives relatively soft β-rays ($\mu = 21{\cdot}5$) with intense penetrating γ-rays. The results suggest that of the atoms of ThC, 35 per cent. emit α-particles of range 4·8 cm. and become converted into ThD, while the remaining 65 per cent. emit β-particles and disintegrate into atoms of a very short-lived α-ray product ThC_2 of 8·6 cm. range. If these results are justified the following equivalent schemes show the process diagramatically—





In the second scheme C_α and C_β do not denote different substances, but the same substance breaking down in two different ways. A. E. G.

1715. *Transformations in the Active Deposit of Thorium.* **[Miss] L. Meitner.** (Phys. Zeitschr. 13. pp. 623–626, July 1, 1912.)—The experiments of Marsden and Barratt have shown that in the disintegration of the active deposit of thorium a branch occurs, the two products, giving α-rays of ranges 8·6 and 4·8 cm., being on different branches in the ratio 1·8 : 1. Further, the authors suggested that ThC_1 (α, 4·8 cm. 60 min.) is derived directly from ThB (β, 10·6 hrs.) and that between ThB and ThC_2 (α, 8·6 cm., very small period) there exists a β-ray product ThC′ of about the same period of ThC_1. In the present experiments the authoress has obtained experimental evidence of the existence of ThC′, which she has been able to separate chemically from ThC_1. The evidence depends on the fact that practically all the γ-rays of the active deposit come from ThD. An acid solution of Th active deposit is taken and a Ni plate dipped in for some time. This Ni plate removes all the ThC products and leaves behind pure ThB. The curves of growth in activity of the α- and γ-rays both rise in this case from zero to a maximum after about 220 minutes. However, if a few drops of $SnCl_2$ are added to the solution of the active deposit before putting in the Ni, the activity of the residue as measured by α-rays rises from 18 per cent. of the final maximum, while that measured by γ-rays rises from zero. This suggests that the ThD (β + γ) comes from one side of the branch only, and that its parent is completely separated out on the Ni, while the other "C body" remains behind. E. M.

1716. *Helium in Gases from Springs.* **C. Moureu** and **A. Lepape.** (Comptes Rendus, 155. pp. 197–200, July 16, 1912.)—While the rare gases argon, krypton, xenon, and neon seem to occur in natural springs approximately in quantities of the same order as in the atmosphere [see Abstract No. 446 (1912)], the percentage of helium is sometimes far higher, and some springs in the Côte d'Or contain 10 per cent. of He in their total gas made up of nitrogen and the rare gases. The Source Carnot at Santenay yields 17,845 litres of He per year. This helium might be "young" (liberated as it is formed) or fossil (liberated after long accumulation). The former assumption would require the disintegration of 91 tons of radium or of 500 million tons of pitchblende per year for the production of the helium, and seems to be out of the question. H. B.

1717. *The Penetrating Radiation.* **W. W. Strong.** (Terrestrial Magnetism, 17. pp. 49–69, June, 1912.)—The paper contains a detailed *résumé* of the work done on natural ionisation by various observers, and more particularly the part played by penetrating radiations. The experimental evidence seems to show that at some places the penetrating radiation is nearly constant in value and probably comes almost entirely from the ground. At other places considerable variations are found in the intensity of the ionisation currents in closed vessels, and the accepted explanation of these is that the penetrating radiation itself varies greatly in intensity. The simplest way of explaining these variations is that of assuming their source to be radio-active products in the air. The author discusses problems for future research relating to the penetrating radiation. E. M.

1718. *Analysis of Waters of Thermal Springs of Bath.* **I. Masson** and **W. Ramsay.** (Chem. Soc., Journ. 101. pp. 1370–1376, July, 1912.)—The paper deals with an examination of the gases evolved and also of the solid residue. 5368 litres of gas escape daily from the waters, the composition of which per litre was found to be carbon dioxide 86 c.cm., argon 7·268 c.cm., neon 2·384 c.cm., helium 0·297 c.cm., and the rest nitrogen. Air contains these rare gases in the proportion: A 9·32, Ne 0·0124, He 0·00408 c.cm. per litre, so that the Bath gas contains 0·78 times as much argon, 188 times as much Ne, and 73 times as much He as are contained in ordinary air. The gas evolved was found to contain the niton (radium emanation) per million litres in equilibrium with 33·65 mgm. metallic Ra. The waters themselves were found to contain 0·1387 mgm. Ra per million litres; the small quantity being probably due to the high percentage of sulphates. E. M.

HEAT.

1719. *Heat Conductivity of Crystals.* **R. W. Clark.** (Science, 36. p. 415, Sept. 27, 1912.)—The author describes a modification of the Senarmont method for studying heat conductivity in crystals in which the disturbing effects due to radiation are eliminated. A plate of the mineral, for example, gypsum, about 1–2 mm. thick is dipped in melted paraffin until a thin even coat is formed on one side. The plate is then placed on the stage of the instrument with the paraffined surface down, but insulated from the stage by strips of asbestos under the edges. The point of the conducting wire rests in a depression in the upper surface. In this way the heat conducted along the wire to the crystal must actually be transmitted through the gypsum before it can melt the paraffin. A very sharply defined ellipse is noted in the paraffin; this is clearly due to differences in conductivity of the gypsum in different directions and not to radiation from the wire. T. M. L.

1720. *Thermal Conductivity of Rocks at High Temperatures.* **H. H. Poole.** (Phil. Mag. 24. pp. 45–62, July, 1912.)—Describes determinations of the thermal conductivity of limestone and granite at temperatures ranging from 35° to 540° C. The specimens dealt with were in the form of long cylinders, which could be heated in an electric furnace; heat was generated electrically along the axis of the cylinder by means of a Pt-wire, and from a knowledge of the amount of heat thus generated and the temperatures at two points at different distances from the axis, the conductivity could be determined in the usual way. The temperatures were measured by Pt—Pt-Ir couples. For limestone the results obtained may be divided into three series. The first 7 results, between 35° and 300° C., lie fairly well along the curve $K = (3{\cdot}885 + 2{\cdot}59\,e^{-0{\cdot}00914\theta}) \times 10^{-3}$. The next 9 results, between 160° and 390° C., lie roughly on a straight line $K = (4{\cdot}48 - 0{\cdot}002756\theta) \times 10^{-3}$. The last last 19 results, between 40° and 370° C., lie approximately on the curve $K = (3{\cdot}14 + 1{\cdot}99\,e^{-0{\cdot}00914\theta}) \times 10^{-3}$. The progressive lowering of the conductivity is due to the baking of the stone, which was found to be greatly altered when finally removed from the furnace. Experiments with slate failed, as the rock split when heated. With granite, the first three results lie on a curve similar to those obtained with limestone. The next 6, ranging between 84° and 450° C., lie along the curve $K = (4{\cdot}215 + 1{\cdot}07\,e^{-0{\cdot}01187\theta}) \times 10^{-3}$. The last two determinations at 587° and 443° C. gave the same result $K = 3{\cdot}95 \times 10^{-3}$, indicating further lowering of the conductivity when the rock was heated above 450° C. A. W.

1721. *Experimental Determination of the Ratio of the Specific Heats, C_p/C_v, of Potassium and Sodium Vapours.* **M. Robitzsch.** (Ann. d. Physik, 38. 5. pp. 1027–1032, Aug. 13, 1912. Extract of Inaug. Dissertation, Marburg, 1910.)—The apparatus used was similar to that of Wenz [Abstract No. 157 (1911)], certain modifications being introduced in order to make the reading of the position of resonance in the tube containing the vapours more precise. The temperatures used varied between 660° and 1000° for potassium vapour, and between 750° and 920° for sodium vapour; they were determined by wave-length measurements in air, all other conditions being the same as when potassium or sodium vapour was used. The ratio of the specific heats does not vary within the temperature limits mentioned, and has the value 1·64 ± 0·007 for potassium vapour and 1·68 ± 0·03 for sodium vapour; it follows that the vapours of these elements are monatomic. The ratio of the velocity of sound in potassium vapour to that in air is 0·938 ± 0·002, whilst with sodium vapour the ratio is 1·233 ± 0·006; these ratios are independent of the temperature. T. S. P.

1722. *Relation of the Specific Heats of Carbon Dioxide at Low Pressures.* **B. Beckman.** (Ark. för Mat., Astron. och Fysik, Stockholm, 7. 27. pp. 1–9, 1912.)—Using Kundt's original method, the author has measured the velocity (u) of sound, and hence the ratio $c_p : c_v$, or k, of dry CO_2 at 15° and at various pressures, p, between 1 and 0·1 atmo. The mean results are as follows:—

p	760	392	244	149	100	76 mm.
u	265·1	265·4	265·4	265·4	266·2	266·2 metres per sec.
k	1·3045	1·301	1·298	1·296	1·303	1·302

The slight diminution observed in the value of k (0·7 per cent.) when the pressure falls from 760 to 150 mm. lies almost within the limits of error of the measurements. T. H. P.

1723. *Revision of the Critical Constants of Liquefiable Gases.* **E. Cardoso.** (Archives des Sciences, 34. pp. 20–31, July, 1912.)—The author gives the results obtained in conjunction with various other investigators, in 1909–1911. The method employed allows of an accuracy of 0·05° in the critical temperature, and of 0·05 atmo. in the critical pressure. The numerical results are given in the following table, which also indicates the region in which the critical opalescence in the neighbourhood of the critical condition is observed.

Gas.	Crit. Temp. Absol.	Crit. Press. Atmos.	Beginning	Maximum	End
			of the Opalescence.		
C_2H_4	282·50°	50·65	9·05°	—	9·50°
N_2O	309·50	71·65	36·00	36·30	36·50
H_2S	373·40	89·05	—	—	—
C_2H_6	305·10	48·85	32·00	—	32·40
CO_2	304·00	72·85	30·60	—	31·00
SO_2	430·15	77·65	—	—	—
C_2N_2	401·30	59·75	128·00	128·15	128·30
C_2H_2	308·50	61·65	35·15	35·35	35·50
NH_3	132·90	112·30	132·60	132·75	132·90
HCl	51·40	81·55	—	—	—

T. H. P.

1724. *Critical Constant and Orthobaric Densities of Xenon.* **H. S. Patterson, R. S. Cripps, and R. Whytlaw-Gray.** (Roy. Soc., Proc. Ser. A. 86. pp. 579–590, July 20, 1912.)—Rudorf having pointed out [Abstract No. 1568 (1909)] that the atomic volume of xenon should be greater than that of krypton (instead of smaller as found by Ramsay and Travers with only 3 cm.³ of xenon), since the atomic volumes in groups of elements either increase with the atomic weight or remain constant, the authors redetermined the constants of xenon with the 120 cm.³ of xenon of Ramsay and Moore, which they purify with the utmost care, finally using only 20 cm.³ of the gas. The orthobaric densities (water = 1) found at 16°, 0°, −66·8° are: vapour density, 0·844, 0·421, 0·059; liquid density, 1·468, 1·987, 2·768; the mean densities observed and calculated are in close agreement at all the 15 temperatures, for which figures are given. The liquid density at the boiling-point would be 3·068, and the atomic volume 42·7, showing that in the argon series there is rise of both liquid density and of atomic volume with rise in atomic weight. Although elaborate measures were taken to ensure the purity of the xenon, certain subsequent experiments suggested a slight contamination. The density of the gas remained unchanged after sparking with hydrogen, but was found slightly too low after sparking with oxygen; the gas might contain some oxygen, or some unstable oxide might be formed, or some absorption or solution of oxygen might take place. H. B.

1725. *Joule Cycle.* **G. Koenigs.** (Comptes Rendus, 154. pp. 1082–1084, April 22, 1912.)—In internal-combustion engines, where pressure is more important than temperature, Joule cycles may be substituted for Carnot cycles, but the efficiency must only be a function of the extreme pressures. If $G(p, S)$ is the thermodynamic potential of the body with regard to the variables p (pressure) and S (entropy), G must have the special form $G(p, S) = f(p)h(S) + g(p)$, where $f(p)$ is a positive and increasing function of p, and $h(S)$ an increasing function of S. E. E. F.

1726. *Wien's Displacement Law.* **E. Buckingham.** (Phil. Mag. 23. pp. 920–931, June, 1912.)—Although Wien's displacement law may be regarded as quite well established by experiment, its great importance seems to justify attempts to improve or simplify the reasoning by which it may be deduced *a priori* as a consequence of the general principles of thermodynamics and the electromagnetic theory of radiation. Any such deduction must, in substance, contain the following four elements: (*a*) The treatment, by Doppler's principle, of the change of wave-length produced when diffuse radiation is compressed or expanded within a perfectly reflecting shell, *i.e.*, adiabatically. (*b*) The evaluation, by means of the principle of the conservation of energy, of the change of the volume density of the radiant energy which occurs during the adiabatic change of volume and accompanies the change of wave-length. This step involves the use of the value of the pressure of diffuse radiation on a bounding surface, deduced from the electromagnetic theory and confirmed by experiment. (*c*) The demonstration, by means of the second law of thermodynamics, that black radiation remains black when its density and temperature are changed by adiabatic change of volume. (*d*) The use of the Stefan-Boltzmann law to correlate the results obtained by the steps (*a*), (*b*), and (*c*), so that the displacement law shall appear as a necessary consequence of those results. The above order is followed in the present treatment, though it is not regarded as indispensable. It is claimed that in the derivation of the law here presented greater clearness has been attained without any real sacrifice of rigour, and by the use of the most elementary means only. E. H. B.

1727. *On Vapour-pressure Lines of Binary Systems with widely divergent Values of the Vapour-pressures of the Components.* **P. Kohnstamm.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 96–118, June 25, 1912.)—A theoretical paper which cannot be abstracted.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1728. *A Particular Kind of Electric Current.* **Gouy.** (Comptes Rendus, 155. pp. 608–611, Sept. 30, 1912.)—A non-electrified body may be considered as having equal and opposite charges of electricity. These charges have ordinarily the same velocity as the body, and so we may consider that there are two electric currents produced by the motion which exactly neutralise one another. In certain circumstances, however, it is conceivable that the velocities of the charges may not be equal, and so the motion may produce true convection currents producing ordinary effects. The author, taking the case of an incandescent gas in which a small fraction of the molecules are decomposed into positive and negative electrons, investigates mathematically what effects would be produced by phenomena of this nature. A. R.

1729. *Report of B.A. Electrical Standards Committee.* (Electrician, 69. pp. 1061–1062, Oct. 4, 1912. Paper read before the British Assoc. at Dundee.) —The general progress made with absolute measurements of current and resistance is reported to be most satisfactory. With regard to material standards, measurements of resistance, of current, and of e.m.f. are now made on the same basis in practically all civilised countries. During 1911, four special resistance coils were measured at the Bureau of Standards, the National Physical Laboratory, and the Reichsanstalt. The mean values assigned to the coils are as follows:—

No. of Coil.	Bureau of Standards.	National Physical Laboratory.	Reichsanstalt.
11	$1·00005_3$	$1·00005_1$	$1·00004_0$
12	5_5	5_2	4_1
8939	9_9	10_0	8_5
8940	9_9	10_0	8_7

The results of measurements of the e.m.f. of the Weston normal cell, in which measurements the current was determined by means of a silver voltameter, show good agreement, notwithstanding that voltameters of various types and capacities and electrolytes from various sources were employed. The average deviation from the mean is between 3 and 4 parts in 100,000. Comparisons of standard cells have been made at the National Physical Laboratory, the Bureau of Standards, the Laboratoire Central d'Électricité, and the Reichsanstalt. A number of the cells changed slightly in e.m.f. during transit, but on the whole the agreement is within 2 or 3 parts in 100,000. F. E. S.

1730. *Surface Leakage with Alternating and Continuous Electric Pressures.* **G. L. Addenbrooke.** (Phys. Soc., Proc. 24. pp. 288–290; Discussion, p. 291, Aug., 1912.)—The results of experiments on the surface leakage of dielectrics are given. It is found that the surface leakage does not obey the ordinary laws of metallic conduction. With highly attenuated films of moisture the losses with alternating currents are greater than those with direct current. Further experiments seem to show that the phenomena are due to capacity effects. A. R.

1731. *The Electric Charge on Rain.* II. **J. A. McClelland** and **J. J. Nolan.** (Roy. Irish Acad., Proc. 30. 4. pp. 61–71, Sept., 1912.)—The present paper deals with a continuation of the work described in an earlier one [see Abstract No. 855 (1912)]. The previous series of observations extended over the months March–June, 1911, while the present series covers the period Oct., 1911–May, 1912. Except for certain minor alterations the apparatus employed remains the same as during the earlier series of observations. Observations of the potential gradient were taken on one occasion only. Of the total amount of rain collected 82·6 % was found to be positively charged, while of the total amount of electricity brought down 76·9 % was positive. Tables are given showing the results obtained for each month. These show that the charge per c.cm. of rain tends to be lower in the winter than in the summer. As in the previous work the rain has been separated into three types—"fine rain," "large rain," and "mixed rain." Large rain is always highly charged, the average value being 1 to 2 e.s. units per c.cm. The largest charge per c.cm. to be measured was one of 12·8 e.s. units on March 5, 1912. Mixed rain is weakly charged. On both these types positive electricity predominates, but fine rain is always negatively charged. Tables are given showing the current per sq. cm. of earth's surface brought down by the rain. Snow occurred on one day only. Summing up, the authors state that there appears to be no doubt that a large excess of positive electricity is brought down to the earth by rain. Their work shows that the rain occurring during normal electrical conditions is charged, generally speaking, in a similar manner to thunderstorm rain, and they suggest that the conditions which Simpson assumes to account for the latter may exist also in normal rain. J. S. Di.

1732. *Atmospheric Electricity during Solar Eclipse, April* 17, 1912. **A. Brommer.** (Phys. Zeitschr. 13. pp. 684–687, July 15, 1912.)—Observations of the variations of atmospheric electrification were made at the Vienna Radium Institute during the progress of the eclipse. The results are tabulated and given in a curve showing the variations from 9.30 a m. to 4.30 p.m. [See Abstracts Nos. 1788 (1905); 346, 1091 (1906).] C. P. B.

1733. *Electric and Magnetic Vectors.* **J. Miczyński.** (Phys. Zeitschr. 13. pp. 710–715, Aug. 1, 1912.)—A mathematical discussion, based on Lorentz's form of the Maxwell-Hertz fundamental equations, and treating the significance, on the electron theory, of the electric and magnetic vectors. E. H. B.

1734. *Theorem of Sufficient Cause and Electromagnetic Field.* II. **H. Witte.** (Deutsch. Phys. Gesell., Verh. 14. 18. pp. 844–855, Sept. 30, 1912.)—[For first part see Abstract No. 1241 (1912).]

DISCHARGE AND OSCILLATIONS.

1735. *Ionisation produced by Collision of Positive Ions in Gaseous Mixtures.* **R. D. Kleeman.** (Cambridge Phil. Soc., Proc. 16. pp. 621–630, July 24, 1912.)—A circular wire-gauze and metal plate are situated parallel and near to one another. The gas on the side of the gauze not facing the metal plate is ionised by α-particles. By means of a weak electric field the positive or negative ions can be drawn through the gauze into the space between the gauze and plate. A p.d. exists between the gauze and plate, which may be increased to such a value that fresh ions are produced by collision. The conditions are thus different from those usually adopted, in which the ions are produced in the strong electric field, and the electrons and smallest positive particles produced are seized upon by the field before they can attach themselves to neutral molecules, and given a large velocity which prevents this taking place later. In the experiments the curves connecting electric field and ionisation current are obtained in the neighbourhood of the point where ionisation by collision commences, and the alterations of the shapes of the curves when small quantities of foreign gases are introduced, are investigated. The results are discussed in the light of the author's view that the nature of an ion cluster in a gas (not under the action of external forces) is continually changing, and that a crowd of ions consists at any instant of a number of simple ions and clusters of various degrees of complexity [Abstract No. 548 (1912)]. The results indicate, among other things, that when an atom of a molecule is ionised by an α-particle the whole molecule may sometimes be broken up into its constituent atoms. The author concludes that the smallest positive particle which can be obtained from an ionised atom is characteristic of it, and consists of the whole atom *minus* a negative electron. E. M.

1736. *Discharge of Electricity by Hot Bodies.* **H. A. Wilson.** (Phil. Mag. 24. pp. 196–197, July, 1912.)—In 1908 the present author applied thermodynamical reasoning to the calculation of the current carried by ions emitted by a hot body. The result may be written $p = A\theta^{(1+a/R)}\epsilon^{-w_0/R\theta}$, where p is the equilibrium pressure due to ions emitted at absolute temperature θ. R the gas constant, A a constant, and w the work required for an ion to escape is supposed given by $w = w_0 + a\theta$, where a is a constant. In 1912 O. W. Richardson has given a similar calculation of p as a function of θ, but arrives at a different conclusion. The difference is due to the fact that in the more recent work a term was neglected which is only negligible when the constant a has a particular value, whence it appears that Richardson's method of calculation with this correction only confirms Wilson's expression. [See Abstracts Nos. 145 (1904) and 1897 (1912).] E. H. B.

1737. *Electrical Behaviour of Metallic Vapours in Flames.* **E. N. da C. Andrade.** (Phil. Mag. 24. pp. 15–36, July, 1912.)—The subject which is concerned with the deviation in the electric field, the conductivity and light emission of metallic vapour in the Bunsen flame, is dealt with in the following sections:—General behaviour of the luminous streak in the electric field. Methods of measuring the conductivity. Calculations of the number of free electrons in the metallic vapour. Relation between conductivity and light emission. Apparatus for the experiments at high pressures. Measurements of the luminosity of the streak, and the weight of salt vaporised. Migration of the positive carriers at high pressure. Experiments at reduced pressures. Relation between conductivity and pressure. Theoretical considerations. As the result it is found that negatively-charged luminous metallic carriers can exist in a flame, in addition to the known positive carriers. If a streak of metallic vapour stand between, but not touching, two electrodes in the flame, Ohm's law holds for the conductivity of the vapour within the observed range. If a cooled negative electrode be employed, with a given voltage a definite max. current is obtained on displacing a luminous metallic vapour streak between the electrodes towards the negative electrode in the flame. An estimate of the number of free electrons produced per sec. in the streak may be obtained from this. The conductivity and energy of light-emission of a streak of metallic vapour are proportional within the observed range. The energy of light emission for a given rate of vaporisation of metal is roughly independent of the pressure. The velocity of migration of the positive carriers of the luminous streak is inversely proportional to the pressure, and hence the fraction of the time during which a carrier is positively charged is independent of the pressure. This leads to the theoretical conclusion that the impact of metal atom against metal atom is the main cause of the liberation of an electron from a metal atom. A. E. G.

1738. *Experiments with Kathode Rays.* **W. Ramsay.** (Nature, 89. p. 502, July 18, 1912.)—The two following experiments were carried out in conjunction with N. Collie. Four Röntgen-ray bulbs which are so deeply stained as to be rejected are broken up, the stained glass placed in a combustion-tube connected with a Töpler pump, and any adhering air displaced by frequent washing-out with pure oxygen. The tube is then heated to bright redness, and the gas collected placed in communication with a small bulb of cooled charcoal, in order to condense out all gases except hydrogen, helium, and neon. The residual gas is run up into a capillary tube, in which its spectrum can be examined. The spectrum is mainly that of He, but there is a trace of Ne. Some calcium fluoride is prepared by precipitation, washing, and heating to redness, and then exposed to the continued action of kathode rays. The surface turns purple, and silicon fluoride, oxygen, and CO are evolved. In order to maintain the vacuum best suited for kathode rays, a little oxygen is admitted from time to time. The gases evolved during some days' bombardment are rejected, to make sure that no adhering gases are collected in the final experiment. These gases are pumped off four times. The fifth quantity of gas is examined. After absorption of the condensable gases, the residue consists of pure Ne without a trace of He. From these experiments it would appear that not merely atoms of He in rapid motion are capable of communicating sufficient energy to molecules and atoms on which they impinge to cause them to disintegrate, but that electrons in motion, in the form of kathode rays, can be made to play a similar part. A. E. G.

1739. *Sputtering due to Canal Rays.* **V. Kohlschütter.** (Jahrbuch d. Radioakt. 9. pp. 355–418, July 2, 1912.)—This paper gives a *résumé* of the work on this subject under the following sections:—A classified list of the papers to which reference is made. Historical review and method of research. Experimental facts relative to sputtering due to canal rays, such as: dependence of kathode sputtering on the nature of the discharge; dependence on the gas pressure; sputtering and kathode-fall; influence of current; influence of the nature of the current; influence of the shape of the vessel; influence of temperature. The dependence of the sputtering of the kathode on material used is next dealt with as follows:—The degree of sputtering of the various metals; influence of the various gases upon degree of sputtering; secondary action of materials; appearances due to sputtering; sputtering due to canal rays behind the kathode; theoretical consideration of the phenomenon. A. E. G.

1740. *Theory of the Glow Discharge.* **R. Seeliger.** (Ann. d. Physik, 38. 4. pp. 764–780, July 12, 1912.)—An endeavour to explain a group of properties peculiar to glow discharges, viz.:—The changes in the length of the positive column and of the Crookes' kathode dark space with current and pressure. E. H. B.

1741. *Mathematical Analysis of Stationary Waves in the Secondary of an Induction Coil supplied with Alternating Current.* **A. A. Petrovskij.** (Acad. Sci. St. Pétersbourg, Bull. 11. pp. 847–852, June 15, 1910, and 17. pp. 1207–1217, Dec. 1, 1911.)—The author shows mathematically that, with change in the number of alternations, a series of maxima is obtained in the current in the secondary, corresponding in resonance with the fundamental tone and the overtones of this coil. The most distinct maximum corresponds with the fundamental tone, the sharpness gradually diminishing with heightening of the overtones. Similar phenomena take place with reference to the potential at the terminals of the coil. T. H. P.

1742. *The Braun Tube and Oscillations of Small Amplitude.* **H. Fassbender** and **E. Hupka.** (Phys. Zeitschr. 13. pp. 559–561, June 15, 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—A Braun tube designed for the photographic investigation of oscillations of small amplitude, *i.e.* as low as 20 volts, is described. The deflection of the kathode rays is brought about electrostatically, both in the case of the oscillation under investigation and in that of the sine oscillation, which is used to deflect the beam in a perpendicular direction. The condenser plates for the oscillation of small amplitude are 25 cm. long and 2·5 cm. apart. The other condenser plates are outside the thick part of the tube and are 10 cm. apart and 10 cm. broad. The total length of the tube is 1 m. and it is mounted so that its axis is in the direction of the earth's magnetic field, so as to eliminate the effect of this field on the beam. A current coaxial with the tube is used to constrict the beam. A photograph taken with an exposure of 0·3 sec. is given. T. P. B.

1743. *Application of Heaviside's Resistance Operators to Circuits coupled Electrostatically, Electrically, or Magnetically.* **W. H. Eccles.** (Phys. Soc., Proc. 24. pp. 260–284; Discussion, pp. 284–285, Aug., 1912.)—In circuits possessing constant inductance, resistance, and capacity, the differential equations for the currents and the voltages are linear with constant coefficients. They may therefore be solved by the aid of the known simple properties of symbolic operators. The symbolic operator method proves peculiarly adapted to problems in connection with air-core transformers not only when the impressed e.m.f. is an exponential function of the time, but also when it is impulsive. The author discusses the cases where the coupling is purely magnetic, purely electric, and where it is partly magnetic and partly electric. He proves that the circle diagram of a transformer can be generalised so as to take into account what happens when a damped e.m.f. wave is applied. In the second section of the paper improved methods of computing the free periods and the damping factors of a coupled system having two degrees of freedom are given. In the third section he investigates the currents and the voltages produced in the circuits by the sudden application or removal of a constant, a harmonic, or a damped harmonic e.m.f., and of those produced by the application of electromotive impulses. Formulæ showing the effect of the various types of symbolic operator when the applied e.m.f.'s are impulsive are deduced and tabulated. Using these tables of integrals it is easy to write down quickly the solutions appropriate to any given transformer under the action of any of the types of e.m.f. specified. The problem of a spark-circuit and its antenna is worked out under resonance conditions for various couplings and time graphs are made of the primary and secondary currents and voltages. A further example given is the solution for the incidence of a natural electric wave (a "stray") on a receiving antenna and its resonant secondary. In the *discussion*, **R. Appleyard** drew attention to a general method of calculation given recently by H. W. Malcolm. [See Abstract No. 1247B, 1912.] A. R.

1744. *Electric Oscillations in a System of Three Coupled Condenser Circuits.* **F. Müller.** (Jahrbuch d. Drahtlosen Telegraphie, 6. pp. 18–27, July, 1912.) —The paper is theoretical and cannot be fittingly abstracted. It is shown that if the natural period of all three circuits is the same (viz. n), if the oscillations are undamped and the two coupling coefficients are the same (viz. k_1), then the oscillation in the first and third circuits is composed of three oscillations of frequencies $n/\sqrt{(1+k)}$, n, $n/\sqrt{(1-k)}$, where $k=\sqrt{(2)}k_1$, the amplitude of these oscillations being in the ratio of $\frac{1}{2}:1:\frac{1}{2}$. The oscillation of the second circuit is composed of two oscillations of equal amplitude and of frequencies $n/\sqrt{(1+k)}$, $n/\sqrt{(1-k)}$. The case in which the first and third circuits have the same frequency (different, however, from that of the second) is also considered, as is also the case of damped oscillations.

T. P. B.

1745. *High-frequency Currents.* **W. Duddell.** (Engineering, 93. pp. 702–704, May 24, 1912. Discourse delivered at the Royal Institution, May 17, 1912.) —The author deals with the three usual methods of obtaining such currents, namely, (1) from special alternators; (2) by means of Leyden-jar discharges; (3) by arc methods. Under (1) the alternators of Alexanderson and of Goldschmidt are described, with illustrations. Under (2) the shock excitation method and that of Galletti are briefly dealt with. Finally the Poulsen arc is discussed. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1746. *Hallwachs-effect in Selenium.* **G. Zoltán.** (Phys. Zeitschr. 13. pp. 454–460, May 15, 1912.)—Selenium was melted on a metallic disc and cooled rapidly. Some preparations were annealed at 217° C. to convert the selenium into the grey crystalline modification. The metallic plate was made the negative plate of an air condenser and was illuminated by a mercury lamp and charged by means of a water battery. The other plate of the air condenser was connected with a quadrant electrometer. The Hallwachs photoelectric current was measured by the angular speed of the electrometer needle, recorded on a chronograph. The results show (1) in the case of the crystalline Se that the photoelectric sensitiveness increases after the time of preparation, especially if kept in the light; the sensitiveness is increased by positive electrification at ordinary or low pressures, but reduced by negative electrification in the open air; (2) in the case of amorphous Se, which has a higher sensitiveness than the crystalline variety, the sensitiveness is reduced by light, and recovers in the dark. Negative electrification at all pressures diminishes the sensitiveness, while positive electrification increases it.

E. E. F.

1747. *Electrical Conductivity of Metallic Alloys in the Liquid State.* **K. Bornemann** and **G. v. Rauschenplat.** (Metallurgie, 9. pp. 478–486, Aug. 8, and pp. 505–515, Aug. 22, 1912.)—The authors have continued the work of Bornemann and Müller [Abstracts Nos. 1189 (1910) and 688 (1911)], and have devised an apparatus for investigating metals which dissolve carbon. The binary systems Cu-Sb and Cu-Ni have been investigated completely, dilute solutions of Li, Na, Ca, Cd, and Th in Hg, of Sb, Cd, Th, and Pb in Na, of Th in K, and of Pb, Zn, Sb, and Na in Sn have been studied and Cu_2S has been tested in both the solid and liquid states. The results show, that generally speaking, a metal may increase or decrease the conductivity of another one acting as solvent, regardless of whether its conductivity is greater or less than that of the solvent. In dilute solutions, however, it appears that the metals with the greatest tendency to form compounds have the greatest lowering effect. Antimony provides an exception to this rule, for it increases the conductivity of copper in spite of the existence of two stable compounds. The compound Cu_3Sb is marked on the concentration-conductivity curve by a sharp minimum, while $NaHg_2$ and KHg_2 show a distinct maximum. In the case of solid alloys, there is a parallelism between the conductivity-concentration and temperature coefficient of resistance-concentration curves. This appears to hold good for concentrated liquid alloys but not for dilute solutions. In the Cu-Sb alloys the values are sometimes negative at low temperatures and positive at high temperatures, due to thermal dissociation of the CuS_3. Cu_2S also shows a negative temperature-coefficient due to similar causes. With the exception of K and Na the temperature coefficients of resistance of pure metals are very small, pointing to simple molecular aggregation in the liquid state. F. C. A. H. L.

1748. *Action of Condenser in Induction Coil.* **W. H. Wilson.** (Roy. Soc., Proc. Ser. A. 87. pp. 69–78, July 26, 1912. Electrician, 69. pp. 862–863, Aug. 30, 1912. Abstract.)—Curves are obtained of the secondary e.m.f. and of the currents in all the parts of the primary circuit of an induction coil by Joubert's rotating-contact method. These curves show the oscillatory nature of the main primary and condenser currents. They show that the condenser is equally effective, whether it is placed across the primary or across a secondary of a similar number of turns, provided the magnetic leakage is small. In order to obtain the max. secondary e.m.f. of a coil, *when the frequency of interruption is high*, the time constant of the primary must be reduced, at least if a low-voltage supply is used, *i.e.* the self-induction of the primary must be reduced, but this would reduce the natural period of oscillation of the primary condenser circuit, whereas this period must be long if sparking at the interrupter is to be reduced to a minimum. The secondary e.m.f. curves indicate that the period may not be lengthened simply by increasing the condenser capacity. A special arrangement was therefore devised whereby magnetising turns of low self-induction can be combined with an oscillating circuit of long periodic time, which periodic time can be reduced to any desired extent after interruption of the battery current. The arrangement of the circuits is shown in the Fig. given in Abstract No. 1003B (1910). T. P. B.

1749. *Precision Comparator for Diametral Measurements.* **F. Göpel.** (Zeitschr. Instrumentenk. 32. pp. 229–234, July, 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—In 1910 the Reichsanstalt commenced the construction of an apparatus for the absolute determination of the ohm.

Part of this apparatus is a coil of bare wire wound in a screw-cut groove on a hollow marble cylinder of 85·4 cm. diam. In order to measure the diam. of the coil a special comparator has been constructed. The coil is mounted on a mandrel and supported in bearings which form part of the frame of the comparator. The frame also carries on each side of the coil and 1 mm. distant from the wire winding a straight rigid bar in which is let a silver strip. A longitudinal reference line is cut in each silver strip, and these 2 lines serve as a basis of reference for the diametral measurements. The comparison of the coil diam. with the distance between the reference marks is carried out by glass contact pieces, the contact end being a narrow polished surface 8·5 mm. wide and 0·8 mm. high. Part of the surface of the contact piece is graduated in half-millimetres, and the distance between these ½-mm. lines and the reference line on the silver strip is read by means of a microscope. F. E. S.

1750. *High-temperature Electric Furnace.* **D. F. Calhane** and **E. E. Bard.** (Metallurgical and Chem. Engin. 10. pp. 461–463, Aug., 1912. Electrician, 69. pp. 818–819, Aug. 23, 1912. Abstract.)—Detailed description of a small crucible furnace which can easily be assembled and dissembled and be fed without transformer from 110-volt mains. The body is built up of cement slabs of various compositions (cement, sand, magnesia asbestos) cast in moulds. The crucible is made of alundum and rests on alundum; the carbon core surrounding it fits into ring-shaped projections of the upper and lower carbon electrodes to ensure uniform current distribution. The inner space is packed with magnesia asbestos. A larger furnace for 7 kw. is being built. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

1751. *Curie's Constant in the Ferromagnetic State.* **J. R. Ashworth.** (Nature, 89. p. 503, July 18, 1912.)—The author has previously pointed out the analogy which exists between the passage of a fluid from the liquid to the gaseous state and the passage of a magnetic substance from the ferro- to the para-magnetic state, and that the equation of van der Waals represents the salient features of the latter [see Abstract No. 1688 (1910)]. In magnetism it is possible to suppress more or less completely the term representing the mutual attraction of the magnetic molecules by running an alternating current through the magnetic substance. The equation thus simplified represents very well the curves of magnetisation at different temperatures and under these conditions. The author finds from observations on such magnetic isothermals the following mean values for the constant which corresponds to R in the fluid equation: For iron between 15° and 700° C., $4{\cdot}85 \times 10^{-6}$; for nickel between 15° and 800° C., $21{\cdot}1 \times 10^{-6}$. The reciprocals of these values are according to theory, Curie's constants, and the actual numbers are in good agreement with determinations by Curie, Weiss, and Bloch, in experiments made at temperatures above the critical point. Curie's constant therefore appears to be independent of the temperature and may be applied to bodies in the ferromagnetic state. A. D. R.

1752. *Magnetic Properties of Nickel-Manganese Alloys.* **J. G. Gray.** (Phil. Mag. 24. pp. 1–14, July, 1912.)—The specimens were cylindrical rods, 21 cm. long and 0·9 cm. in diam., composed of pure nickel and of Ni and Mn in proportions varying from 5 Mn with 95 Ni, to 30 Mn with 70 Ni. The specimens were tested magnetometrically at room temperature and at —190° C. in the

conditions brought about by the process of casting, annealing at 900° C., and quenching at 900° C. respectively. The addition of manganese diminishes the susceptibility of the nickel. The most remarkable alloy of the series is that containing 20 per cent. Mn, in which the improvement of magnetic quality caused by cooling to —190° is enormous. When quenched at 900° the specimen was non-magnetic at room temperature; but at —190° it possessed very decided magnetic properties. Specimens which contain more than 80 per cent. Mn are only feebly magnetic. These alloys, unlike Hopkinson's nickel-steel, remain unchanged in magnetic quality after a change of temperature from room temperature to —190° and back to room temperature.
G. E. A.

1753. *Kerr-effect.* **W. Dziewulski.** (Phys. Zeitschr. 13. pp. 642–649, July 15, 1912.)—Gives first theory relating to the Kerr-effect for normal incidence of the light, and then describes research with a Fuess polarisation spectrometer on mirrors of steel, cobalt, nickel, magnetite, Heusler's alloys, and iron and nickel deposited on glass. Light from an arc lamp was passed through a monochromator, being then reflected by means of a prism through a hollow pole-piece of a large electromagnet on to the mirror attached to the other pole-piece; from this the light returned to the polarisation apparatus. The rotation of the plane of polarisation, and also the ellipticity of the reflected beam, was measured for different fields and a number of wave-lengths. Both ϕ, the rotation of the polarisation plane, and χ, the ellipticity of the reflected light, are negative for steel, cobalt, and iron deposited on glass. For nickel the rotation is negative, but the ellipticity changes sign in the neighbourhood of 600 $\mu\mu$, becoming positive for the red. Both ϕ and χ change sign for crystals of magnetite. For iron and nickel deposited on glass similar results were obtained as with massive mirrors, but the absolute values of ϕ and χ are in general smaller. All results are tabulated. [See also Abstracts Nos. 1858 (1906) and 842 (1912).]
A. W.

1754. *The Earth's Magnetic Field.* **W. F. G. Swann.** (Phil. Mag. 24. pp. 80–100, July, 1912.)—The paper discusses the possibility of the magnetic field being a phenomenon arising out of the rotation of the earth. The most hopeful basis is to be found in the view that each volume element of the earth contributes a portion to the field as a result of its rotation; for, in the case of the rotation of a surface charge, the horizontal magnetic field for a given potential would depend only on the angular velocity and not on the size of the sphere. Any such theory is restricted by the conditions that it must not involve (*a*) any large effect due to the earth's translatory motion, (*b*) any appreciable magnetic field when a sphere of moderate size is rotated in the laboratory with reasonable angular velocity, (*c*) any measurable effect at the earth due to the rotating sun, (*d*) a field at the sun's surface sufficiently large to be detected by the Zeeman-effect. The author first considers the theory that the magnetic field is due to the existence of an ordinary current brought about by the earth's rotation. The current density σ may be written as equal to $\sigma_1 + \sigma_2$, where σ_1 represents all terms involving the acceleration α of a particle towards the earth's centre, and σ_2 represents terms involving products of powers of α and of v (the linear velocity of a particle). A term of the type σ_1 proportional to α gives rise at the equator to a horizontal magnetic field $H = (4/15)\pi\sigma_0 a^2\omega^2$, where σ_0 is the current density 1 cm. from the axis of rotation, and a and ω are the radius and angular velocity respectively of the earth. The current density $\sigma_0 a\omega^2$ which must exist on the equator at the surface in order to account for the earth's field thus amounts to 7 × 10^{-10} e.m. units. At first sight the permanent existence of such currents would seem unreasonable in view of the apparent necessity for the rapid conversion of their energy into heat owing to friction. But it is necessary here to take a closer view of matter than one involving considerations of resistance, viscosity, &c., and to look upon the permanent existence of these currents as one of the necessary conditions for that fine-grained dynamical equilibrium of matter, the elucidation of which must necessarily involve the explanation of viscosity and resistance themselves in its scope. Such currents may originate in two ways. We may suppose that in ordinary matter corpuscles do occasionally leave the atoms and join those corpuscles which exist between them, the balance being kept up by a reabsorption into the atoms of similar corpuscles. Then, if the rotation results in a very slight want of symmetry fore and aft in the rate of expulsion of these electrons, we have an explanation of the current. This would not require a marked radio-activity, for we are not dealing with the complete expulsion of corpuscles from the matter. The chance of a corpuscle leaving an atom, due to the comparatively large pull exerted on it by an adjacent atom, and remaining in the vicinity of the atoms would be enormously greater than the chance of the corpuscle getting away altogether. Again the current might be explained by the free electrons which exist between atoms. In the case of a piece of matter at rest, their average velocity and mean free path are independent of the direction; but, if the matter be in motion, we may expect from the principle of relativity that these quantities will vary according to the direction of motion. The author then proceeds to consider two further hypotheses, viz., (1) that each volume element may act as though it were charged, or the rotation may result in some kind of radial distribution of the charge, and (2) that each molecule of the earth may be looked upon as equivalent to a very feeble magnet owing to want of complete compensation of the magnetic fields due to its orbital electronic motions, and the rotation of the earth may bring about an orientation of these molecular magnets in favour of one direction. With regard to the first of these hypotheses the author finds it necessary to imagine that corresponding to the volume distribution there is also a surface distribution of equal total amount in order that there should be no considerable electrostatic field at the surface. Why the surface and volume charges should not mix cannot be satisfactorily explained. The second hypothesis too is unsatisfactory, as it appears to violate condition (*b*) stated above. Finally the author suggests how, on the explanation of the earth's field as arising from currents brought about by the rotation, it may yet prove possible to adequately explain the want of coincidence of the magnetic and geographical axes and the secular and annual, &c., variations. A. D. R.

1755. *Hall-effect in Bismuth with High-frequency Currents.* **A. W. Smith.** (Phys. Rev. 35. pp. 81–85, Aug., 1912.)—Observations made by Des Coudres by his own method as to the Hall-effect in bismuth indicated the same value for frequencies from 50 to 700 per sec. as for direct currents. The work of v. Traubenberg on Bi for frequencies of 60 per sec. leads to the same conclusion. If the Hall-effect is caused by the deflection of the electrons in the metal in some such way as the kathode rays are deflected by a transverse magnetic field, the electrons in the plate would always be deflected in the same way, since the magnetic field and the current in the plate alternate simultaneously. If for this or any other reason an appreciable time is required to build up the Hall e.m.f. at the electrodes, the method of Des Coudres is not adapted to detect this fact. A method in which the direction of the magnetic field remains fixed and the current in the plate is alternating, so that the Hall e.m.f. is also an alternating e.m.f., seems to give a more nearly correct measure of the Hall-effect for alternating currents. The author then found from his experiments that the Hall constant (R) is not a function of the frequency, as the following figures show :—

Plate.	Frequency.	R.
A......................	0	2·77
	0	2·75
	60	2·75
	30,000	2·73
	50,000	2·74
	120,000	2·74
B......................	0	2·47
	0	2·46
	60	2·46
	30,000	2·47
	50,000	2·50
	120,000	2·47

[See Abstract No. 1636 (1905).] E. H. B.

RADIOLOGY AND ELECTROPHYSIOLOGY.

1756. *New Apparatus for Production of a Rhythmic Faraday Current.* **E. J. Durand.** (Archives d'Él Médicale, 20. pp. 242–251, Sept. 10, 1912.)—The essential part of the apparatus consists of a fixed coil for inducing the current and a movable coil to carry the induced current ; the latter has a very short length in comparison to its diam., while the former is very elongated. The secondary forms the bob of a pendulum, the time of swing of which can be regulated by a sliding counterpoise, while its movement is brought about by means of an electromagnet. In the ordinary Faraday apparatus the current obtained is regulated entirely by displacement of the primary. In the new apparatus it can be regulated by displacement of the secondary, by altering the resistance, and by the partition of the induced current, or by a combination of these methods. The duration of discharge can be arranged by altering the position of the counterpoise. The apparatus can also be arranged for the production of slow interruptions. A. E. G.

1757. *A New Radiometer.* **W. Hampson.** (Röntgen Soc., Journ. 8. pp. 70–71 ; Discussion, pp. 71–72, July, 1912.)—By means of the new radiometer the work is always carried out by artificial light. With Sabouraud pastilles there is a great difference in the test-pieces : a close examination by artificial light shows a great change from the tint observed by daylight. In the instrument here described the scale of tints gives very small variations of colour ; it has the further advantage that it is possible to start at any stage in the scale. It is often found that different observers arrive at very different results when matching the colours. In the new apparatus this error of judgment is eliminated, and further, by its use the work can, it is said, now be done in half the time originally necessary. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1758. *Atomic Weight of Chlorine.* **G. Baume** and **F. L. Perrot.** (Comptes Rendus, 155. pp. 461–464, Aug. 19, 1912.)—The authors have made a number of careful determinations of the atomic weight of chlorine by the combination of gaseous hydrogen chloride with known weights of liquid ammonia and weighing of the ammonium chloride formed. Assuming the atomic weight of nitrogen to be 14·009, that of chlorine is found to be 35·465, which is in good agreement with that given in the International Table. T. H. P.

1759. *Scandium.* **R. J. Meyer** and **H. Goldenberg.** (Chem. News, 106. pp. 12–14, July 12, 1912.)—By means of an excess of potassium iodate, thorium iodate is precipitated from a nitric acid solution as a flocculent, amorphous precipitate. Sufficient potassium iodate is used to precipitate simultaneously some scandium iodate, otherwise a complete separation of the thorium cannot be ensured. Different specimens of scandium oxide, which had been freed from thorium by the above method, gave 44·11–44·20 as the atomic weight of scandium, in agreement with the results obtained by Nilson. Speter, using the sodium carbonate method to separate scandium from thorium, obtained a scandium oxide which spectrographic and electrometric methods showed to be free from Th, but which gave an atomic weight of 45 for Sc. The authors find that the oxide of atomic weight 45 gives an arc spectrum identical in every respect with that of the oxide of atomic weight 44·1, and draw the conclusion that the spectrographic and electrometric methods are not sensitive enough to detect 0·5 per cent. of thorium oxide in scandium oxide. The determination of the coefficient of magnetisation afforded, however, a delicate method of discriminating between the two oxides, the coefficient of magnetisation of the oxide of atomic weight 45 being $+0·04 \times 10^{-6}$, that of the other oxide being $-0·12 \times 10^{-6}$. This scandium is diamagnetic, as also are its homologues lanthanum and yttrium in the third group of the periodic system. Further experiments are necessary to determine the accurate atomic weight of scandium. T. S. P.

1760. *Formation of Neon as a Product of Radio-active Change.* **W. Ramsay.** (Chem. Soc., Journ. 101. pp. 1367–1370, July, 1912.)—In a previous paper Cameron and the author described experiments from which it was concluded that neon is produced when niton (RaEm) is left in contact with water [Abstract No. 1318 (1908)]. The present paper deals with further evidence on the question. The analysis of the gases evolved from the springs at Bath has shown that they contain 188 times as much neon as ordinary air per litre [see Abstract No. 1718 (1912)]. This neon is presumed to come from the action of the niton (RaEm), since the gases also contain an abnormal amount of the latter. Experimental evidence is also given as follows:—0·103 cub. mm. of niton was sealed off in contact with a solution of $Th(NO_3)_4$ in about 5 c.cm. of water and left for 2 years. The gases were then pumped off, and found to show the spectra of He and Ne, the He being present in amount about 0·31 cub. mm. and the Ne about 0·17 cub. mm. Examination showed that the neon could not have come from air, which might have been presumed to leak into the apparatus. Thus if niton decomposes in presence of water neon is produced. It may be a disintegration product of the niton consisting possibly of the union of five atoms of helium, or it may be that the water plays some part in the action. **E. M.**

1761. *Existence of Chemical Compounds of Short-lived Radio-active Elements.* **H. Schrader.** (Phil. Mag. 24. pp. 125–134, July, 1912.)—The short-lived radio-active transformation products of Ra, Th, and Ac, which are included under the name of active deposits, do not differ fundamentally in their physical properties from the elements of long life such as Ur, Th, and Ra. Their electrochemical properties are similar to those of the common metals; they appear to be present in solutions as ions, and it would therefore seem probable that they are capable of forming chemical compounds in the same way as the long-lived products. If these compounds do exist, evidence of their presence can be obtained from a study of some of their physical properties, a method usually employed in differentiating between homogeneous bodies. In the present case where bodies present only in extremely small quantities are under examination, recourse has been had to their volatility and their solubility. Makower has made some experiments on this point, and found that RaC, after being dissolved in HCl and the solution evaporated to dryness, volatilised from surfaces of Pt and quartz in air at the same temperature as before the treatment. In the present experiments the active Pt-wire is exposed for 10 to 15 min. to gases and vapours which are thought capable of acting chemically on the active material; hydrochloric, hydrobromic, hydriodic acids, bromine, and chlorine are used for the purpose. The action of HCl on the active material does not affect the volatility of actinium B. Bromine, however, produces an increase in the amount volatilised at a given temperature. That this effect is not due to any action on the Pt is shown by similar results obtained when using a quartz surface. Chlorine and hydriodic acids also increase considerably the volatility both of AcB and of AcC. From a quartz surface, after treatment with hydriodic acid, AcC volatilises at a lower temperature than AcB. It is possible that a very thin layer of water of thickness about 10^{-6} mm. which absorbs the gaseous acids may have a considerable influence. In support of this assumption it is found that, after treatment with HCl, actinium B is more easily dissolved off a Pt surface by water than before such treatment. It is obvious from experiments described that the nature of the surface and of the surface-layer is an important but indefinite factor in the volatilisation of minute quantities. For this reason condensation experiments, in which the factor is partly eliminated, are next made. These experiments are conducted in air and hydrogen, and it is found that the radio-active matter when once volatilised condenses on a surface at a much lower temperature in an atmosphere of hydrogen than in air. This suggests that the active matter forms compounds in the presence of air which are less volatile and consequently easier to condense than the reduction products obtained in hydrogen, which are perhaps the elements, *i.e.* the metals themselves. This assumption is in agreement with the behaviour of common metals and their oxides, the former being generally more volatile than the latter. The fact that the volatilisation of AcB from Pt takes place over a long range of temperature may be due to the partial oxidation of the active substance. [See also next Abstract.] **A. E. G.**

1762. *Volatility of Radium C.* **A. S. Russell.** (Phil. Mag. 24. pp. 134–137, July, 1912.)—Schrader's results show that the constituent elements of the radio-active deposits are capable of forming chemical compounds [see preceding Abstract]. Makower has shown that RaA and RaB and RaC cannot remain on a Pt surface when it is heated *in air* to temperatures of 900°, 600°, and 1200° C. respectively. From a quartz surface RaC is not completely removed by prolonged heating to 1820° C. On the other hand, the author has shown that in tubes containing impure RaEm which has simply been pumped off from a Ra solution and sparked down (therefore containing an excess of *hydrogen*), RaA, RaB, and RaC are completely volatilised at a temperature of 650° C. The apparent inconsistency between these two sets of observations is now very simply explained by Schrader's results. Makower determined the volatilisation-points of RaA, &c., under conditions such that part at least of the three products are oxidised. The author, on the other hand, worked under conditions such that the bodies were present either as the elements themselves or as compounds other than oxides. To confirm the truth of this conclusion, experiments are now carried out in which the volatilisation-points are determined in atmospheres of oxygen and hydrogen. In the presence of oxygen all three are non-volatile from a surface of quartz below 700° C., the volatilisation-point of RaC being higher than 1200° C. In the presence of hydrogen they all are completely volatile from a quartz surface below 650° C., the volatilisation-point of RaC being about 860° C. Provided hydrogen is present with the emanation in excess of impurities such as CO_2 or traces of water, RaC volatilises at the lower temperature; if oxygen is in excess, volatilisation takes place at the higher temperature. The results obtained are thus consistent with previous observations of both Makower and the author, and support the hypothesis of Schrader, namely, that two different compounds of RaC are formed in the two sets of experiments. A. E. G.

1763. *Chemical Nature of Thorium X, Radio-actinium, and Thorium B.* **A. Fleck.** (Chem. News, 106. p. 128, Sept. 13, 1912. Paper read before the British Association at Dundee.)—Marckwald and Keetman's statement that thorium and uranium X could not be separated was submitted to as thorough a chemical examination as possible. The chief method employed in the attempted separation was fractional precipitation. No separation could be effected. Similarly radio-actinium could not be separated from thorium, while thorium B and lead were also found to be a pair of chemically non-separable elements. E. M.

1764. *Action of Sunlight and of Radium on Glass.* **W. A. D. Rudge.** (Cambridge Phil. Soc., Proc. 16. pp. 571–578, July 24, 1912.)—The author has exposed different kinds of glass to strong sunlight (at Bloemfontein) and also to a radium preparation. In the case of sunlight the max. colouration was attained in 2 months, except in the case of Jena glass which showed no effect. The effects of radium were more intense than sunlight. The author considers that the amethyst colouration produced in certain glasses is due to the presence of manganese. E. M.

1765. *Apparent Change in Weight during Chemical Reaction.* **J. J. Manley.** (Roy. Soc., Phil. Trans. 212. pp. 227–260, Sept. 12, 1912.)—The author's preliminary experiments in connection with the apparent change in weight accompanying chemical reaction led him to the conclusion that any observed apparent changes in weight depend on fluctuations which are the natural outcome of certain unsuspected variables associated with the glass reaction vessels used and their contents. These variables may be generated by:—(*a*) Very small, yet sufficiently distinct, irregular and unequal convection currents in the air near the balance pans; (*b*) slight differences in the total external areas of the two vessels used according to the method of Landolt; (*c*) a want of strict equality in the temperature of the contents of the two vessels. It is shown that the variable (*a*) may be corrected by completely enclosing the pans and stirrups by means of shells having a very high conductivity for heat. In connection with (*b*), it is pointed out that the superficial areas of two vessels of similar form and *equalised* volumes may vary considerably, and consequently the amount of water-vapour condensed on the surface will vary and thus affect the result. The error may be obviated by removing the water-skins, and this is done most satisfactorily by passing streams of dry and purified air continuously through the balance until just before the actual weighing is commenced. The variable (*c*) is connected both with the manner in which the vessels are finally prepared for weighing and with the nature of the substance used for wiping them. The less frequently the operation of wiping the glass vessels is repeated (silk is shown to be better than linen), the greater is the reliability of the final results.

Using the refinements indicated above, the author then investigated the reaction which takes place between silver nitrate and ferrous sulphate, and which was also used by Landolt. The results were irregular and unsatisfactory, and it was found that the reason for this was that the reaction does not take place strictly according to the usually accepted reaction, namely, $6AgNO_3 + 6FeSO_4 = 6Ag + 2Fe_2(SO_4)_3 + 3Fe(NO_3)_3$, but that gases are evolved, which consist of a mixture of nitrogren and nitric oxide, in the approximate ratio of 1 : 2 by volume. The pressure exerted by these gases distends the reaction vessels and thus causes errors. When the reacting substances were barium chloride and sodium sulphate the apparent increase in mass was of the order of 1 in 109,000,000 parts, which confirms the almost universally accepted belief that a given total mass is an unchanging and unchangeable quantity. The degree of accuracy attained in the weighings was ± 0·006 mgm., whereas that attained by Landolt was ± 0·03 mgm.

T. S. P.

1766. *Reduction of Quartz by Hydrogen.* **H v. Wartenberg.** (Zeitschr. Elektrochem. 18. pp. 658–660; Discussion, p. 660, Aug. 1, 1912. Paper read before the Deutsche Bunsen-Gesell., Heidelberg, May, 1912.)—Since thermocouples rapidly deteriorate when heated in hydrogen in the presence of silicates, the author investigates whether SiO_2 is reduced under formation of SiH_4 or of Si vapour. SiH_4 heated in bulbs of Jena glass is decomposed at 360°, at lower temperatures only in the presence of Sabatier's nickel as catalyst; at 1600° abs. p_{SiH_4}, is $1·3 \times 10^{-6}$ atmo. Attempts were also made to determine the vapour density of silicon. When hydrogen is passed through a quartz tube at 1600°, the cooled capillary through which the H escapes becomes clogged with a brown powder of Si, but there is no SiH_4 in the escaping gas. In a current of nitrogen, SiO_2 does not sublime at 1700°, but it does in hydrogen; this is probably the reason why quartz wool is found in blast-furnaces and volcanoes. The silicon vapour seems to consist of polyatomic Si. **A. Coehn** mentioned in the *discussion* that quartz is reduced in ultra-violet light by hydrogen in the presence of moisture already at temperatures a little above 100° C.

H. B.

1767. *Disintegration of Metals at High Temperatures.* **J. H. T. Roberts.** (Nature, 89. p. 660, Aug. 29, 1912.)—The loss of weight of a hot Pt-wire in nitrogen, hydrogen, and in a vacuum is zero; occluded gases do not carry any metal with them. In the presence of oxygen a black oxide of platinum is deposited on the walls of the containing vessel, which, on being heated, turns into a metallic mirror; this mirror, but not the oxide, can then be dissolved in aqua regia. The weight of metal lost and of oxygen absorbed correspond to the formation of the oxide; the loss diminishes when the oxygen pressure is diminished. H. B.

1768. *Disintegration of Metals by Heat.* **G. Reboul** and **E. G. de Bollemont.** (Journ. de Physique, 2. Ser. 5. pp. 559–568, July, 1912.)—A sheet of Pt and a strip of Cu are fixed so as to face one another at a distance of about 1 mm. within a tubular electric furnace. A black deposit forms on the Pt; it has the shape of the copper strip, a cross, *e.g.* But the deposit disappears again on further heating, after ½ min. at 900°, and after 30 min. at 400°; this had not been observed by Blondlot. The previous history of the two metals, especially of the copper, has a very great influence; on repeating the experiment the deposits become much feebler. The Pt may be replaced by Al, Ni, Au (not by Ag) without making any difference; the phenomena are practically the same in air and in a vacuum, and not very different in different gases, O, N, CO_2. Placed in hydrogen only the outline of the cross is seen, however. When the copper is replaced by Ni, Fe, Al, no effect is observed; but Ag behaves like Cu. When the distance is increased to a few mm. the phenomenon becomes much less marked. The authors suggest that the occluded gases cause an explosive projection of metallic particles at temperatures depending upon the metal. H. B.

1769. *High-pressure Chemical Reactions.* **F. Bergius.** (Zeitschr. Elektrochem. 18. pp. 660–662, Aug. 1, 1912. Paper read before the Deutsche Bunsen-Gesell., Heidelberg, May, 1912.)—For the study of equilibria the author has constructed an apparatus in which pressures of 150 atmos. can be maintained for 20 days at 300° C. When calcium oxide is fused in some agent, it will combine with oxygen at 350° and 120 atmos., and yield calcium peroxide. Charcoal and coke are burned to hydrogen and CO_2 (not CO), when in contact with liquid water within an iron bomb, oxidised inside. Wood and peat heated in the bomb assume spontaneously a higher temperature, because the cellulose is decomposed. In this case the liquid water (contained in the fuel or added to cellulose) served as heat store; but it was not possible to produce a natural coal containing more than 5 per cent. of hydrogen in this way, though the composition of the coal changed much with temperature and length of heating period. The gases generated are CH_4 and CO_2. Estimates of the time required for the formation of natural coal are based on these experiments. H. B.

1770. *Preparation of Metallic Tungsten.* **G. Erhard.** (Metallurgie, 9. pp. 441–446, July 22, 1912.)—The author describes the process used for the manufacture of tungsten at Schmiedeberg. After bismuth has been extracted by lixiviating the roasted, finely-ground ore with HCl of 6° to 7° Bé, the residue is dried and mixed with excess of soda (60 % over the theoretical amount required). The mixture is roasted, and by subsequent fine grinding and re-roasting it has been found possible to extract 97 % of the WO_3 present. If the mass is sintered it is ground, and the sodium tungstate boiled out by means of hot water. The solution is concentrated until crystals begin to separate; they are caught on a sieve, dried, and treated with HCl containing 6 % HNO_3. The yellow tungstic acid is washed, filtered, dried, and mixed with 14 per cent. of its weight of charcoal and 2 % resin to act as a briquetting material. Reduction in a crucible follows, the metal obtained containing 92 to 94 % tungsten. It is purified to 96·5 % by crushing and washing with running water. F. C. A. H. L.

1771. *Production and Use of Alloys containing Manganese.* **A. Hänig.** (Elektrochem. Zeitschr. 19. pp. 131–133, Aug., and pp. 159–161, Sept., 1912.)—Manganese is used industrially in the form of ferro-manganese (high or low in carbon), silico-manganese, silico-spiegel, copper manganese, and phosphor-manganese. Silico-manganese is obtained by reducing a mixture of silica and oxide of manganese (or rhodonite) by means of carbon in the electric furnace. The alloy finds considerable use in making the new manganese steels, since it allows of increasing the Mn without unduly affecting the carbon. It is also of considerable use in deoxidising steel during the ordinary processes of manufacture, since it does not produce a gaseous product on combination with oxygen. F. C. A. H. L.

1772. *Nickel-Cobalt System.* **R. Ruer** and **K. Kaneko.** (Metallurgie, 9. pp. 419–422, July 8, 1912.)—The authors show that these metals form a continuous series of solid solutions whose liquidus forms practically a straight line from the melting-point of Ni (1451° C.) to that of Co (1491° C.). Microscopic examination indicates that Co and the Co-rich alloys show a greater tendency to twinning than Ni and the Ni-rich alloys. Nickel appears to have the power of dissolving nickel oxide. The temperature of loss of magnetic properties was also determined, and forms a curve, convex upwards, from 360° C. in the case of Ni to 1112° C. for pure Co. F. C. A. H. L.

1773. *Heat Treatment of Nickel Steels low in Carbon.* **H. Fay** and **J. M. Bierer.** (Amer. Soc. for Testing Materials, Proc. 11. 1911. Metallurgie, 9. pp. 455–456, July 22, 1912. Abstract.)—The authors have investigated the mechanical properties of two steels containing respectively 0·35 and 0·34 % C., 0·63 and 0·60 % Mn, and 3·15 and 3·50 % Ni, after heat treatment in various ways. Three pieces of each steel were heated up to the required temperature (600° to 1000° C.), which was maintained for 2 hours, after which time one bar was quenched in oil, another cooled in the air, and the third allowed to cool down with the furnace. Generally speaking, the oil-quenched specimens showed the highest elastic limits, tensile strengths and contractions and the slowly cooled bars showed the lowest values. The most suitable temperature for heat treatment appears to lie between 800° and 850° C., which is well above the critical temperature. F. C. A. H. L.

1774. *Solubility of Cementite in Hardenite.* **J. O. Arnold** and **L. Aitchison.** (Iron and Steel Inst., Journ. 85. pp. 235–239; Discussion and Correspondence, pp. 240–248, 1912. Engineering, 93. pp. 713–714, May 24, 1912.)—Steels containing 1·05 and 1·46 per cent. C. and showing the Ac_{123} point at 727° and 728° C. respectively were heated in a salt bath to temperatures between 741° and 942° C. and quenched in a large volume of cold water and brine. The results of subsequent microscopic examination indicate to the authors that the conversion of pearlite to hardenite is completed over a range of 8° C., *i.e.* the solution of B cementite in iron takes place very rapidly, while that of A, or cementite proper, requires a range of about 190° C. It would thus appear that the diffusion of A is a normal act of solution, while that of B is in the nature of a reduction to a lower compound (hardenite). F. C. A. H. L.

1775. *The Mechanism of Corrosion.* **J. N. Friend, J. L. Bentley,** and **W. West.** (Iron and Steel Inst., Journ. 85. pp. 259–268; Discussion, p. 269, 1912.)—When a plate of iron is suspended in water open to the atmosphere a "corrosion zone" is established round it from which the metal absorbs dissolved oxygen. Experiments have shown that if the metal be so placed that the sides of the vessel cut the zone the rate of corrosion is diminished. In the case of mild steel the radius of the corrosion zone appears to be about equal to the length of the plate. The effect of light has been shown to accelerate the initial oxidation and afterwards to assist corrosion by promoting oxidation of the ferrous oxide. In the course of time the outer layers of rust shut out the light, and then rusting proceeds as in the dark with the result that there is a greater proportion of ferric iron in the outer layers than in the inner layers of rust. F. C. A. H. L.

1776. *Thermal Relations of Solutions.* **W. F. Magie.** (Amer. Philosoph. Soc., Proc. 51. pp. 235–239, July, 1912.)—From a study of the constants of the formula by which the heat capacity of a solution is expressed the author has been led to conclude that the heat capacity of the molecules of water associated with the molecules of a solute is increased, whilst the heat capacity of the water associated with the ions is diminished. He expresses the heat of the dilution by the formula, $l = -a\theta + e$, where θ is the absolute temperature and a is a factor depending on the increase of electrolytic dissociation by dilution, whilst e, which does not usually differ greatly in magnitude from $a\theta$ also varies to a first approximation with the dissociation. The small difference, which represents the heat of dilution, is a function of the concentration and of the temperature. For example, if a solution of barium chloride containing ½ gm.-mol. in 50 gm.-mols. of water is diluted to double its volume at 7° C. 49 gm.-cals. of heat are absorbed. The same dilution at 24·5° C. is accompanied by an evolution of 18·5 gm.-cals. At some intermediate temperature, about 17° C., there is no heat either evolved or absorbed. In all cases the absorption of heat is greatest at the lowest temperature of observation, and diminishes as the temperature is raised, to become positive in some cases, as in the example just given, at temperatures common in an ordinary room. The greater the dilution, the lower the temperature at which the heat of dilution changes its sign. T. M. L.

1777. *Conductivity of Solid Salt Mixtures.* **M. Le Blanc.** (Zeitschr. Elektrochem. 18. pp. 549–552, June 1, 1912. Paper read before the Deutsche Bunsen-Gesell., May, 1912.)—Small increases of conductivity may be produced by the admixture of KF or BaF_2 with PbF_2, or of KCl, NaCl or KF with solid PbCl, but if the experiments are carried out in a dry atmosphere the effects are not large and cannot be relied on to any great extent, since the pure materials are somewhat variable in their behaviour. The very large increases observed by C. Fritsch in 1897 may have been due to the absorption of moisture by a deliquescent added salt. T. M. L.

1778. *Influence of Colloids and Fine Suspensions on the Solubility of Gases in Water.* II. *Solubility of CO_2 and of Hydrogen.* **A. Findlay** and **B. Shen.** (Chem. Soc., Journ. 101. pp. 1459–1468, July, 1912.)—The solubility of CO_2 in solutions of ammonium chloride, potassium chloride, barium chloride, ferrous ammonium sulphate, sucrose, and chloral hydrate is in harmony with Henry's law. The solubility of hydrogen in solutions of dextrin, starch, gelatin, ferric hydroxide, and in a suspension of silver is, with the possible exception of the solutions of gelatin, in harmony with Henry's law. [Compare Abstract No. 1167 (1910).] T. M. L.

1779. *Osmotic Pressure of Concentrated Solutions of Carbon Dioxide.* **O. Sackur.** (Zeitschr. Elektrochem. 18. pp. 641–644; Discussion, p. 644, Aug. 1, 1912. Paper read before the Deutsche Bunsen-Gesell., Heidelberg, May, 1912.)—The osmotic pressure of a gas may be deduced from its absorption-coefficient by means of the equation $v d\pi = V dp$, where π is the osmotic pressure of a solution saturated with the gas under pressure P, whilst v and V are the volumes containing 1 gm.-mol. of the gas in the liquid and gaseous phases. If the absorption-coefficient $k = V/v$ is constant, this equation integrates to $\pi = RTc$, where c is the concentration of the gas in the liquid. Measurements were made of the absorption-coefficient of CO_2 in methyl and ethyl alcohols, acetone, methyl acetate and ethyl acetate at —78° C. and at —59° C., under pressures from 50 to 700 mm. of mercury. The absorption-coefficients were found to be much steadier when using Ostwald's form of Henry's law (in which the concentrations are measured in gm. per c.cm. in the two phases) than when using Bunsen's form (in which the concentration in the liquid is measured in gm. per gm. of solvent). In every case a close agreement was found between π and RTc at low pressures, but at higher pressures deviations up to 5·5 % were observed. The deviations were all of such a character as to indicate that the absorption-coefficient rises according to a linear law from a definite pressure p_0, as if $k = k_0 + a\,(p - p_0)$, whence $\pi = k_0 p + \frac{1}{2}a(p - p_0)^2$. It is remarkable that the deviations from the "gas-laws" should be much smaller in the case of the osmotic pressures of CO_2 than in the case of gas-pressures. T. M. L.

1780. *Electrolytic Dissociation of Potassium Bromide.* **K. Drucker.** (Zeitschr. Elektrochem. 18. pp. 562–567; Discussion, pp. 567–568, July 1, 1912. Paper read before the Deutsche Bunsen-Gesell., Heidelberg, May, 1912.)—The research was started in connection with the recalculation of the ionic mobilities [see Abstract No. 1605 (1907)]. The author and P. Bogdan found that tribenzylammonium bromide (and chloride) are strong electrolytes which yet obey Ostwald's dilution law. The author intended to determine the degree of dissociation of KBr from the effect of this salt on the distribution of this organic bromide between water and bromoform or chloroform; but the organic compound is partly polymerised in these solvents. He therefore prepared concentration cells with electrodes of AgBr and with either of the two and with mixtures of the two bromides. The organic bromide is absorbed by AgBr and also by carbon; but the conclusion is arrived at that for concentrations of KBr up to 0·02 mol./litre the conductivity measurements lead to correct results for the dissociation of the potassium bromide. In the *discussion*, **K. Elbs** objected that the organic bromide would split in solution, and **F. Auerbach** questioned the final conclusion. H. B.

1781. *Velocity of the Hydrogen Ion, and a General Dissociation Formula for Acids.* **J. Kendall.** (Chem. Soc., Journ. 101. pp. 1275–1296, July, 1912.)—If conductivity measurements are carried out with a series of very dilute solutions of a weak acid, the values obtained for the dissociation constant vary greatly according to the value for the velocity of the hydrogen ion used in the calculation of the equivalent conductivity at infinite dilution. With acids of a certain range of strength (100k between 0·1 and 1·0) a satisfactory dissociation-constant at very high dilutions can only be obtained with the use of one particular value for the velocity of the hydrogen ion. The mean of the values deduced from a number of experiments with different acids was $H^{\cdot} = 347{\cdot}0$. A slight modification of this result was afterwards found necessary, the figure finally obtained being $H^{\cdot} = 347{\cdot}2$ at 25° (or 318·9 at 18°), with a max. divergence of $\pm 0{\cdot}4$. The dilution law of Ostwald is not exactly obeyed by the acids employed in the above determination, even in very dilute solution. A formula for the dissociation of these acids, $m^2/(1-m)v = k + c(1-m)/m$, where k and c are constants for each acid, has been developed, and found to be in perfect agreement with the experimental data for the transition acids. This formula has been extended to acids of all types. Ostwald's dilution law for weak electrolytes is a limiting case, since as k decreases c approaches zero; van't Hoff's formula for strong electrolytes is a special case, where k is zero. The above dissociation formula holds, therefore, within the limits of experimental error for all acids. T. M. L.

1782. *Normal and Liquid Potentials of Non-aqueous Solutions.* **N. Isgarischew.** (Zeitschr. Elektrochem. 18. pp. 568–578, July 1, 1912. Paper read before the Deutsche Bunsen-Gesell., Heidelberg, May, 1912.)—Most of the potentials so far determined in non-aqueous solutions being only approximate, the author begins his research with methyl alcohol and a calomel reference electrode, measuring transference with the aid of a Carrara apparatus. The p.d.'s at the junction of the aqueous and alcoholic solutions—neglected by previous investigators—he calculates after Henderson on the basis of experiments with solutions of KCl in water and methyl alcohol. The potentials of Cu, Cd, Zn, Ag, Ni are determined; of these Ni, and also Cd and Zn become passive in methyl alcohol, and the potential of nickel changes quickly from $-0{\cdot}247$ to $+0{\cdot}20$; no passivity is observed when the experiments are made in a hydrogen atmosphere. The potentials found in the alcoholic solutions were substantially higher than those observed in aqueous solutions, except in the case of Ag. H. B.

1783. *Galvanoplasty of Thick Deposits of Nickel; Deposition of Tin and Zinc.* **A. Hollard.** (Bull. Soc. d'Encouragement, 118. pp. 24–29, July, 1912.)—The reason that thick deposits of nickel are not readily obtained without exfoliation occurring, is that hydrogen is generally deposited at the same time as the Ni. The deposition of hydrogen may be prevented by the addition of oxidising agents to the bath or by forming a complex salt of the Ni. Both methods are investigated by the author, but the second is the only really satisfactory one. The best results are obtained with a bath of nickel fluoborate, the preparation of which is fully described. The best deposits of tin are obtained from a bath containing a solution of sodium stannate and sodium sulphate as electrolyte. In the case of zinc, the bath recommended contains zinc sulphate, ammonium sulphate, ammonium acetate, and citric acid.

T. S. P.

1784. *Electrolytic Preparation of Persulphates.* **C. Schall and K. Andrich.** (Chem. Zeit. 36. p. 645, 1912.)—In the electrolytic preparation of persulphates according to the method described by Blumer [Abstract No. 1306 (1912)], the yields obtained were determined by titration of the electrolyte. The authors have endeavoured to determine the yields by collecting and weighing the solid persulphate, but were unsuccessful in the case of ammonium persulphate. With potassium persulphate, however, a current-yield of the solid salt amounting to 71·1 % was obtained. The electrolyte used consisted of 1250 c.cm. of a saturated (at 18·5°) solution of potassium persulphate, to which were added 600 gm. of potassium hydrogen sulphate, 2 gm. of potassium ferricyanide, and 10 c.cm. of concentrated sulphuric acid. It was kept saturated with potassium hydrogen sulphate by immersing a glass vessel, pierced with holes and containing the salt, in the electrolyte. The anode was of Pt-wire and the kathode of nickel-foil, the current-densities being 0·12 and 2·12 amps./cm.^{2} at the anode and kathode respectively, using 16 amps. The temperature was maintained in the neighbourhood of 20°. The details of the apparatus were similar to those given by Blumer (*loc. cit.*).

T. S. P.

1785. *Simultaneous Electrolytic Deposition of Copper and Zinc from Various Solutions not containing Cyanide.* **M. de K. Thompson.** (Metallurgical and Chem. Engin. 10. pp. 458–461, Aug., 1912.)—Eleven complex copper salts were made by the use of the following reagents: Glycerine, cane sugar, tartaric acid, glycocoll, sodium potassium tartrate and sodium hydroxide, sodium thiosulphate, phosphorous acid, ammonia, thioglycollic acid, ammonium oxalate, and sodium pyrophosphate. The solutions of these salts were mixed with a solution of zinc sulphate and then submitted to electrolysis. The only solution which gave a smooth, bright deposit, when electrolysed for an hour or more, was the alkaline sodium potassium tartrate solution; the deposit, however, had a bronze colour. The solutions from which appreciable amounts of zinc were deposited together with copper, were the alkaline potassium tartrate, the oxalate, and the pyrophosphate. It was not found in any case that diminishing the total amount of copper in the solution improved the deposits. It seems that the complexity of the copper salt must be relied on to reduce the concentration of the cupric ions sufficiently to obtain co-deposition of zinc, while there must be enough copper present in the un-ionised state to furnish ions as rapidly as they are used up. T. S. P.

1786. *Electrolytic Analysis with Platinum Electrodes of Light Weight.* **F. A. Gooch** and **W. L. Burdick.** (Amer. Journ. Sci. 34. pp. 107–112, Aug., 1912. Electrician, 69. pp. 956–957, Sept. 13, 1912. Abstract.)—Owing to the high cost of platinum the authors have experimented with various electrodes in which the weight of Pt has been cut down to a minimum. Ordinary electrodes of platinised glass (gas electrodes) are not suitable, as the films flake off during the electrolysis, and are also removed from the glass when the deposited metal is subsequently removed by a suitable reagent. A much more closely adherent film may be obtained when a viscous mixture of glycerol and dry chloroplatinic acid is substituted for the usual plating solution, and on electrodes prepared in this way 0·13 gm. of copper may be deposited quantitatively in 30–40 min., using 2 amps. and rotating the kathode. Similarly, 0·07 gm. of nickel can be deposited quantitatively in 30–50 min. This electrode suffers from the disadvantage, however, that there is a tendency of the film to disintegrate when the deposited metal is subsequently dissolved off the electrode, so that after a few successive determinations the film needs to be renewed; also, there is some tendency to the disengagement of particles during the process of electrolysis. In another form of apparatus the kathode (rotating) consists of a disc of gauze or foil, about 1 cm. square, carried by a rod of lead glass which is fused into the meshes of the gauze or into a central hole in the foil. The kathode rotates in a small cell, made from a thistle funnel, through the bottom of which is fused the anode, also 1 cm. square. With such a small kathode the deposited metal lacks compactness, and is likely to be disengaged from the electrode, so that in carrying out the analysis the cell, together with the electrodes is first weighed, and then, after the electrolysis is complete, the electrodes, cell, and disengaged particles of deposited metal are carefully washed and dried, and weighed again. The results obtained with this apparatus were fairly satisfactory, but it was difficult to carry out the washing thoroughly. To obviate this difficulty a Pt sieve, on which a felt of asbestos was deposited, was fused into a small glass tube, so that the washing could be done by applying suction to the end of the tube, which dipped into the cell, and adding water continuously to the cell until the washing was complete. The sieve tube is weighed with the cell and its electrodes, both before and after the electrolysis. The total weight of the cell and its electrodes is 17–18 gm., and the weight of Pt about 1 gm. Very good results were obtained in the quantitative deposition of copper and nickel, the details being the same as those given with the platinised glass electrodes. T. S. P.

1787. *Electrolytic Reduction of Difficultly Reducible Organic Substances at Thallium Kathodes.* **G. Zerbes.** (Zeitschr. Elektrochem. 18. pp. 619–632, June 15, 1912.)—For the evolution of hydrogen at thallium kathodes a supertension is necessary which is almost the same as at lead, mercury, and cadmium kathodes. Because of this supertension difficultly reducible substances, such as caffeine, pyridine, and succinimide, are readily reduced in the same way as at lead electrodes. In sulphuric acid solution the evolution of hydrogen and the reduction processes follow the same logarithmic law connecting the potential and the current, as was found by Tafel to hold in the case of lead and mercury. The special peculiarity of thallium kathodes is that the current efficiency with respect to the reduction processes does not attain its highest value at the commencement of the electrolysis, but only after some time has elapsed. [See Abstract No. 907 (1905).] T. S. P.

1788. *Electrolytic Reduction.* VII. *Catalytic Action of Copper.* **H. D. Law.** (Chem. Soc., Journ. 101. pp. 1544–1552, Aug., 1912.)—In the electrolytic reduction of a number of organic compounds, chiefly aldehydes and ketones, the author finds that the largest yields are obtained when copper kathodes are employed. Massive copper is the least active, whereas thin sheets give good yields of highly reduced copper. Thick sheet copper, which has been etched with concentrated nitric acid to a fine state of division is extremely active, but the best results are obtained by depositing finely-divided metal, during reduction, on to kathodes of copper-foil. T. S. P.

1789. *Evolution of Chemical Elements and Occlusion of Gases by Metals.* **C. T. Kingzett.** (Chem. News, 106. p. 183, Oct. 11, 1912.)—It is suggested that experiments should be made on gases which have been occluded by metals, to see whether they can be recovered either in their original form or as allotropes, or are transmuted into new elements. T. M. L.

1790. *Nomenclature of Microscopic Substances and Structure of Steel and Cast Iron.* (Mech. Eng. 30. pp. 390–394, Sept. 27, 1912. Report to the Internat. Assoc. for Testing Materials, N.Y., Sept., 1912.)